INSTRUCTION MANUAL

Instructions for instrument serial number	92490032

Esterline ANGUS

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Today, Angus Electronics manufactures a complete line of instruments for industrial power and process applications. Angus products are used throughout the world in innumerable applications: factories, processing facilities, power plants, aerospace, laboratories, and as components in finished products.

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INSTRUCTION MANUAL

FOR

MINISERVO®

STRIP-CHART RECORDER

Esterline ANGUS

Angus Electronics Co. Instrumentation Group, Esterline Technologies

MS723-A
March 31, 1992

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NOTE: FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED WITH THIS MANUAL. SPECIAL DRAWINGS AND SUPPLEMENTARY INSTRUCTIONS THAT MAY BE REQUIRED FOR YOUR INSTRUMENT WILL BE LISTED ON THE DATA SHEET AND WILL ACCOMPANY THIS MANUAL.

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SECTION 1--INSTRUMENT DESCRIPTION

1.1 INTRODUCTION

a. The Esterline Angus MINISERVO is a compact strip-chart recorder designed for all laboratory, industrial, and general field applications. The recorder is available in either of two basic mounting configurations—a portable bench-top unit or a rack/panel mounted unit. Operating on a null-balance potentiometeric principle, it offers the sensitivity, response, and reliability of much more sophisticated servo recorders. The writing system features a single disposable cartridge consisting of a fiber-tip pen and integral ink supply. Either single- or multi-speed[1] chart drives are available, and the strip chart has a full 10cm calibrated span.

b. The appendix in the back of this manual may contain additional information on optional accessories and attachments, plus other documentation that may be required for special modifications. If supplemental instructions or drawings conflict with information in this basic manual, the supplemental data shall be considered authoritative. For a detailed description of your particular recorder, refer to the Data Sheet originally supplied with the instrument.

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[1] Available on bench-top instruments only.

1.2 SPECIFICATIONS

TABLE 1-1. TECHNICAL SPECIFICATIONS.

INSTRUMENT TYPE	Miniature graphic recorder with self-balancing potentiometric (servo) measuring system.
WRITING SYSTEM	Single-channel, cable-driven, with disposable inking-pen cartridge; manual pen lift provided.
RECORDING CHART OPTIONS	
Z-Fold-	Rectilinear with 10cm calibrated span; 20 meters long and 5cm folds.
Roll-	Rectilinear with 10cm calibrated span and 32 meters long.
DC INPUT MEASUREMENT OPTIONS[3]	
Single-Span Millivolts (100mV Basic Amplifier)	Spans ranging from 100mV to 1V.
Single-Span Millivolts (10mV Optional Amplifier)	Spans ranging from 10mV to 1V.
Single-Span Volts (Via External Voltage Dividers Using 100mV Basic Amplifier)	Spans ranging up to 100V (maximum).
Single-Span Milliamps (Via Shunt Resistors Using 100mV Basic Amplifier or Optional 10mV Amplifier)	Zero-based spans[2]: 1mA to 100mA. Zero-suppressed spans[2]: 1-5, 4-20, 10-50mA.
Multi-Span Millivolts (10mV Optional Amplifier)	0-1, 0-5, 0-10, 0-50, 0-100 mV DC; and 0-.5, 0-1, 0-10, 0-50, 0-100V DC. Span selector switch provided on front panel with zero adjustable ±100% of span.
SOURCE IMPEDANCE-	Up to 10K ohms (maximum).

TABLE 1-1. TECHNICAL SPECIFICATIONS (CONT'D).

INPUT IMPEDANCE	Potentiometric to 1V; 1 megohm above 1V.
COMMON MODE REJECTION	DC: 120dB, 100V DC maximum; AC: 100dB, 50V maximum rms line frequency.
STEP RESPONSE TIME	0.5 second F.S.
ACCURACY	
Millivolt, Milliamp, and Voltage Spans	±1.0% of span. Offset drift 2.0μV/°C max.
TEMPERATURE EFFECTS OVER AMBIENT TEMPERATURE RANGE (0-50°C.)	
Millivolt Spans: 100mV Basic Amplifier	±30μV/°C. (maximum).
(Up to 1V) 10mV Optional Amplifier	±5μV/°C. (maximum).
Voltage Spans (Up to 100V)	±.03% of span/°C. (maximum).
Milliamp Spans	±.03% of span/°C. (maximum).
ELECTRICAL ZERO	Right hand (standard); Left hand (optional).
Single Span	Zero adjustable ±10% of span.
Multi-Span (Bench Only)	Zero adjustable ±100% of span.
SERVO AMPLIFIER	All solid-state design with regulated power supply; input over-range protection to ±10V DC on basic spans; also permits servo motor overdrive (zero or full-scale) without damage.
FEEDBACK POTENTIOMETER	Conductive-plastic, rotary type.
SERVO MOTOR	Permanent-magnet, DC rotary type.
AMBIENT TEMPERATURE RANGE	0 to 50°C.
GRADUATED SCALEPLATE	Removable transparent type calibrated for right-hand zero. Left-hand zero optional.
CHART DRIVE SYSTEM OPTIONS [3]	
Single-Speed (feed rate)	3, 15, 60 or 300 cm/hr.; employs 50- or 60-Hz synchronous motor.
Eight-Speed[1] (feed rates)	6, 12, 24 cm/hr; 1, 2, 4, 10, 20 cm/min. at 50 or 60 Hz. Employs DC stepper motor and pulse generating circuitry.
Transport Features	Front loading, manual advance wheel, and chart tear-off bar.
POWER REQUIREMENTS	115V or 230V @ 60 Hz. Selector switch provided on rear panel (1/4A fuse for 115V, 1/8A fuse for 230V supplied). Pulley conversion kit available for 50 Hz operation.
MOUNTING OPTIONS	Bench top or rack/panel mount.
CHASSIS/CASE SIZES	See dimensioning diagram in Figure 1-2.
Bench Top	Front-panel ON-OFF switch, chart-speed selector switch, and multi-span switch with screwdriver zero adjust accessible through center of switch knob. Screwdriver adjustments provided on case left side for span and gain.

TABLE 1-1. TECHNICAL SPECIFICATIONS (CONT'D).

Rack/Panel Mount	Screwdriver adjustments on chassis left side for Zero, Span and Gain are provided.
WEIGHT	
Chassis Only	Approximately 5 pounds.
Bench-top unit	Approximately 11 pounds.
Chassis Installed in Rack/Panel Case	Approximately 8 pounds.
ADDITIONAL OPTIONS	
Remote Pen Lift	Actuated by 24V DC solenoid. Switch- or voltage-type available.
Retransmitting Signal	1V DC span (nominal) analog output provided for minimum load of 5K ohms.
Retransmitting Pot	1K-ohm rotary type. 10V DC maximum applied voltage. 1mA maximum output.

[1] Optional Stepper Chart Speeds: 1.5, 3, 6, 15, 30, 60, 150 and 300 cm/hr.

[2] Voltage drops on current spans: zero-based spans = 100mV (maximum); zero-suppressed spans = 125mV (maximum).

[3] Standard features are reflected in this table. Refer to Data Sheet for options not listed.

1.3 THEORY OF OPERATION

1.3.1 SINGLE-SPAN RECORDER

The complete measuring system employed in a Miniservo recorder is illustrated in the simplified block diagram of Figure 1-1. Analog signals to be recorded are first applied to the system through an input filter network to reject AC interference. This network also includes a pair of biased diodes for input overload protection. In addition, an optional limiter circuit may be used to extend the over-range protection feature of the instrument.

1.3.1.1 PREAMP

a. After the signal leaves the input circuitry, it is next preamplified by IC2—an integrated-circuit opamp. Gain of this stage is regulated by fixed-span resistor R7 and R22 in a closed feedback loop. The selected values of these resistors maintain a nominal preamp output span of 1 volt regardless of the basic input span.

b. From the output of IC2, the preamplified signal E_S is fed to a voltage summing network. A separate output is also made available at this point for the retransmitting signal option. In addition to E_S, the summing network also receives two other voltages--gain regulating voltage e_g from a feedback circuit in the servo amplifier loop, and zeroing voltage E_Z that is established by a manual adjustment when setting the pen to chart zero. Zero adjust R11 affords the operator a ±10% span adjustment for pen positioning.

c. At the output of the summing network, zeroing voltage E_Z and gain regulating voltage e_g are combined with the preamplified signal E_S to form a conditioned signal voltage e_c. This resultant signal is then applied to the first stage of the basic servo-measuring loop (para. 1.3.3).

1.3.2 MULTI-SPAN RECORDER [1]

All principal electronic circuits of the Miniservo Multi-span recorder are constructed on modular printed-circuit boards. The complete measuring system is illustrated in the simplified block diagram of Figure 1-1. Analog signals to be recorded are first applied to span switch S102A. This switch section then routes the signals to switch section S102B; either directly (for spans of 1V or less), or through a voltage divider consisting of resistors R101 and R102 (for spans of 5V or more). From switch section S102B, analog signals are applied to an input filter/limiter network on preamp board PCB201. This network rejects stray interference and includes a pair of zener diodes (CR203 and CR204) for input overload protection. To eliminate long input leads, PCB201 is physically positioned directly behind the front-panel span switch.

---

[1] Available on bench-top instruments only.

1.3.2.1 PREAMP

a. After the signal leaves the input network, it is next amplified by preamp IC202--an integrated-circuit opamp. Gain of this stage is regulated by a closed feedback loop, consisting of resistor R206 and voltage divider resistors R103 - R109. Span switch section S102C is used to select a precision feedback network for each of the eleven spans provided. Offset potentiometer R209 is adjusted for optimum offset drift over normal operating temperature limits of IC202.

b. From the output of IC202, the amplified signal Es is fed directly to a voltage-summing network. This network is located on PCB101 -- a servo amp board mounted within the inner chassis assembly. In addition to Es, the summing network also receives two other voltages -- gain regulating voltage eg from a feedback circuit circuit in the servo amplifier loop, and zeroing voltage Ez that is established by zero-adjust R110 and its accompanying regulator IC201. This system provides a zero adjustment over ±100% of the chart span. Ez, like Es, is fed back directly to the summing network.

c. At the output of the summing network, zeroing voltage E_z and gain-regulating voltage e_g are combined with the amplified analog signal E_s to form a conditioned signal voltage e_c. This resultant signal is then applied to the first stage of the basic servo-measuring loop (para. 1.3.3).

1.3.3 SERVO AMP

a. Signal voltage e_c from the summing circuit is connected to the inverting input of differential amplifier IC1. The non-inverting input of this opamp receives a composite feedback signal E_F, which is made up of voltages E_P and e_v. Voltage E_P is directly proportional to the position of the wiper arm on feedback pot R501A (equivalent to pen position). Damping rate voltage e_v is also picked off at the arm of the feedback pot through differentiating capacitor C2. This dynamic voltage depends upon velocity of the servo motor; and it is therefore effective only when the system is approaching balance, thus helping the motor to anticipate the correct stopping point. The value of C2 has been selected for optimum response characteristics.

b. The differential amplifier compares the analog signal e_c with the feedback signal E_F and, under "off-null" conditions, an error signal voltage e_r is developed at the differential input of IC1. This signal is amplified and then fed to an output driver stage. The driver makes use of complimentary power transistors Q1 and Q2 which, in turn, deliver a DC voltage to the armature of servo motor B102. Drive voltage is applied until the "follow-up" feedback pot reaches a voltage position equal to e_c. At this point the system is "balanced," and the recording pen will come to rest at a new position on the chart. The error signal voltage, which is generated within the measuring system, may be expressed in simplified form as follows:

$$e_r = \left[E_S \pm (E_Z + e_g)\right] \pm \left[E_P + e_v\right]$$

or:

$$e_r = e_c \pm E_F$$

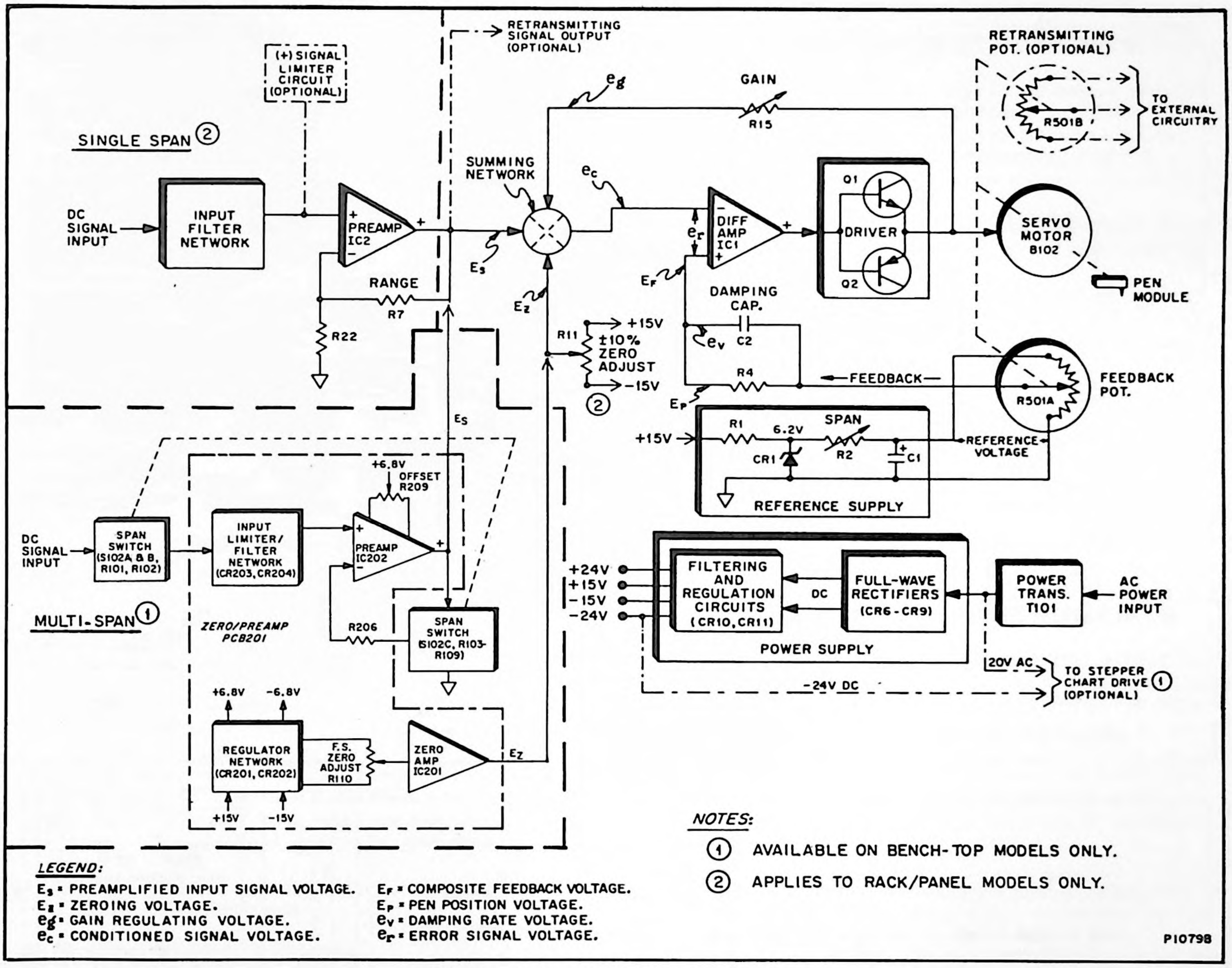
1.3.4 POWER SUPPLY

a. Power is applied to the servo system through step-down transformer T101. The power supply circuit includes a full-wave bridge rectifier that delivers two unregulated DC voltages that are capacitively filtered (+24V and -24V). These 24-volt sources furnish power for the servo motor driver, and the -24-volts is also used in the stepper drive circuitry of the multi-speed chart drive option[1]. In addition, both 24-volt polarities are dropped down to produce a +15-volt source and a -15-volt source. These sources are zener regulated and supply operating potentials for all other stages in the servo system.

b. In the auxiliary reference supply, resistor R1 and zener diode CR1 reduce the +15V source to +6.2V (±5%). This stable temperature-compensated voltage is then utilized as a reference potential for the solid-state feedback pot (R501A). Span control (R2) is provided in the circuit for full-scale calibration adjustment.

---

[1] Available on bench-top instruments only.



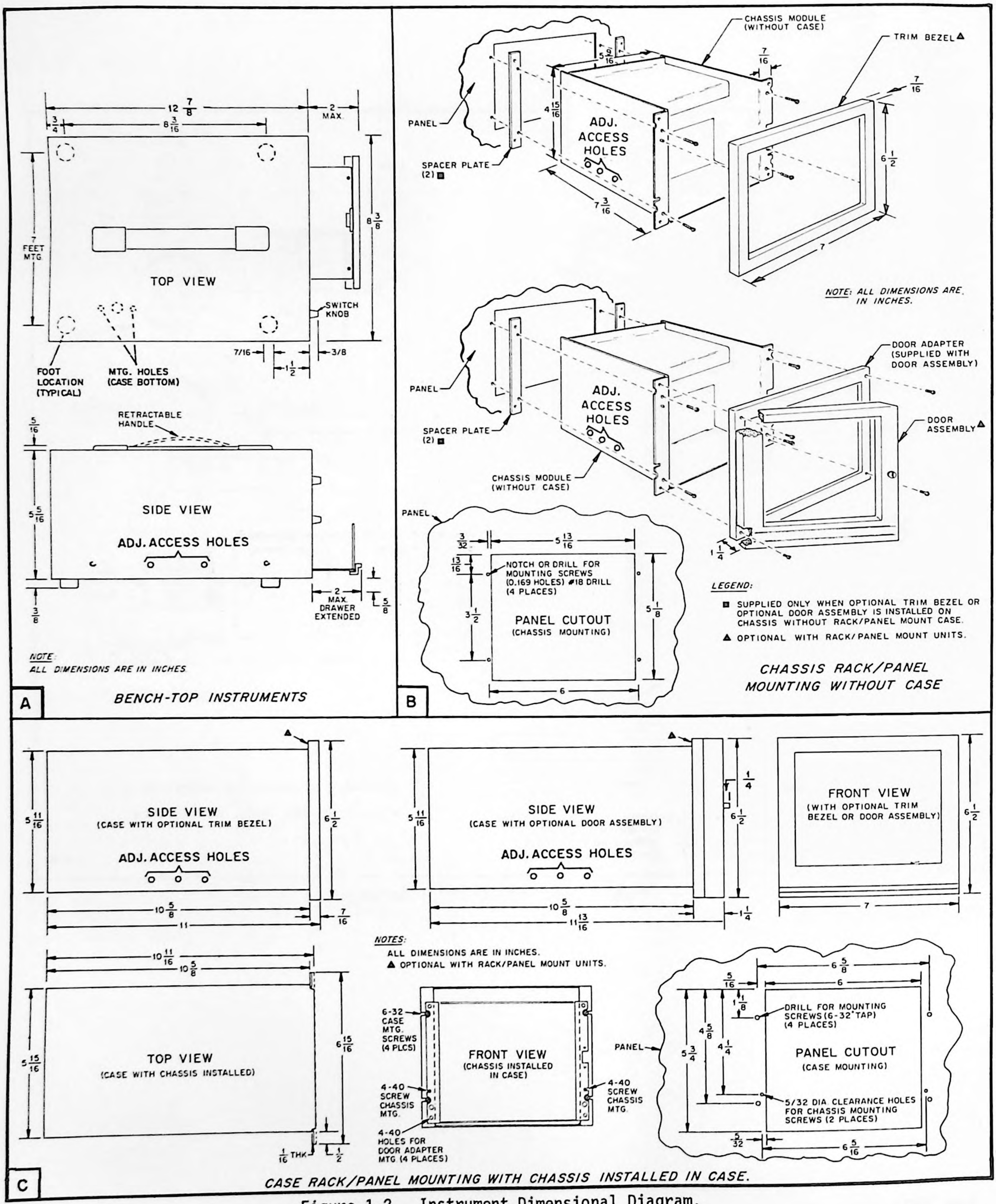
LEGEND:

E_s = PREAMPLIFIED INPUT SIGNAL VOLTAGE.
E_z = ZEROING VOLTAGE.
e_g = GAIN REGULATING VOLTAGE.
e_c = CONDITIONED SIGNAL VOLTAGE.
E_F = COMPOSITE FEEDBACK VOLTAGE.
E_P = PEN POSITION VOLTAGE.
e_V = DAMPING RATE VOLTAGE.
e_r = ERROR SIGNAL VOLTAGE.

NOTES:

① AVAILABLE ON BENCH-TOP MODELS ONLY.
② APPLIES TO RACK/PANEL MODELS ONLY.

Figure 1-1. Functional Diagram.



12 7/8
3/4
8 3/16
2 MAX
7 FEET MTG
8 3/8
TOP VIEW
SWITCH KNOB
7/16
3/8
1 1/2
FOOT LOCATION (TYPICAL)
MTG. HOLES (CASE BOTTOM)
RETRACTABLE HANDLE
5/16
5 5/16
SIDE VIEW
ADJ. ACCESS HOLES
3/8
2 MAX. DRAWER EXTENDED
5/8
NOTE: ALL DIMENSIONS ARE IN INCHES
A
BENCH-TOP INSTRUMENTS
CHASSIS MODULE (WITHOUT CASE)
TRIM BEZEL ▲
5 9/16
7/16
7/16
PANEL
4 15/16
ADJ. ACCESS HOLES
6 1/2
SPACER PLATE (2) ■
7 3/16
7
NOTE: ALL DIMENSIONS ARE IN INCHES.
DOOR ADAPTER (SUPPLIED WITH DOOR ASSEMBLY)
PANEL
ADJ. ACCESS HOLES
DOOR ASSEMBLY ▲
SPACER PLATE (2) ■
CHASSIS MODULE (WITHOUT CASE)
PANEL
3/32
5 13/16
13/16
NOTCH OR DRILL FOR MOUNTING SCREWS (0.169 HOLES) #18 DRILL (4 PLACES)
3 1/2
5 1/8
PANEL CUTOUT (CHASSIS MOUNTING)
6
1 1/4
LEGEND:
■ SUPPLIED ONLY WHEN OPTIONAL TRIM BEZEL OR OPTIONAL DOOR ASSEMBLY IS INSTALLED ON CHASSIS WITHOUT RACK/PANEL MOUNT CASE.
▲ OPTIONAL WITH RACK/PANEL MOUNT UNITS.
B
CHASSIS RACK/PANEL MOUNTING WITHOUT CASE
▲
5 11/16
SIDE VIEW (CASE WITH OPTIONAL TRIM BEZEL)
ADJ. ACCESS HOLES
6 1/2
10 5/8
11
7/16
▲
5 11/16
SIDE VIEW (CASE WITH OPTIONAL DOOR ASSEMBLY)
ADJ. ACCESS HOLES
1/4
6 1/2
10 5/8
11 13/16
1 1/4
FRONT VIEW (WITH OPTIONAL TRIM BEZEL OR DOOR ASSEMBLY)
6 1/2
7
10 11/16
10 5/8
5 15/16
TOP VIEW (CASE WITH CHASSIS INSTALLED)
6 15/16
1/16 THK
1/2
NOTES:
ALL DIMENSIONS ARE IN INCHES.
▲ OPTIONAL WITH RACK/PANEL MOUNT UNITS.
6-32 CASE MTG. SCREWS (4 PLCS)
FRONT VIEW (CHASSIS INSTALLED IN CASE)
4-40 SCREW CHASSIS MTG.
4-40 SCREW CHASSIS MTG.
4-40 HOLES FOR DOOR ADAPTER MTG (4 PLACES)
PANEL
6 5/8
5/16
6
1 1/8
DRILL FOR MOUNTING SCREWS (6-32 TAP) (4 PLACES)
5 3/4
4 5/8
4 1/4
PANEL CUTOUT (CASE MOUNTING)
5/32 DIA. CLEARANCE HOLES FOR CHASSIS MOUNTING SCREWS (2 PLACES)
5/32
6 5/16
C
CASE RACK/PANEL MOUNTING WITH CHASSIS INSTALLED IN CASE.
P1077B

Figure 1-2. Instrument Dimensional Diagram.

Rev.1178

SECTION 2--INSTALLATION

2.1 UNPACKING INSTRUCTIONS

a. Carriers are responsible for damage in transit. If the packing case shows damage, make a notation to that effect on the express receipt or freight bill. If the shipment within is damaged, notify the carrier and your Esterline Angus representative immediately. The following standard items have been inspected and carefully packed in the Miniservo shipping carton:

ITEM	QTY.
Recording Instrument	1
Service Kit (Inking Accessories)	1
Instruction Manual	1
Recording Chart	1

b. Additional items may be supplied when special options are ordered. Such items may include the following for rack/panel installations:

ITEM	QTY.
Trim Bezel	1
Door and Door Adapter	1
Spacer Plates[1]	2
Rack/Panel-Mount Case	1
Hardware Bag	1
Adapter for 19" Relay Rack	1

c. Remove the packing material from the carton carefully and check off all items listed on the packing slip as they are unpacked. If special items were ordered, they will appear on the packing slip. Inspect all contents for damage.

> CAUTION: *Do not* attempt to operate a damaged instrument.

2.2 INSTALLATION

Miniservo recorders are available with a variety of installation-mounting options. These options among others include:

(1) Bench-top with four feet.

(2) Panel mount with trim bezel, with or without case.

(3) Rack mount with door assembly, with or without case.

(4) Case without trim bezel or door.

2.2.1 BENCH-TOP INSTRUMENTS

a. The Miniservo bench-top instruments require no special installation procedures. Four feet are adhesively-attached to the bottom of the recorder for bench-top applications.

b. If it is desired to permanently mount the recorder to a bench, table, or shelf, proceed as follows:

(1) Remove all four feet.

(2) Use two of the unused holes located toward the rear of the case bottom to anchor the base to a stationary surface. Refer to Figure 1-2A for location of mounting holes and physical dimensioning.

2.2.2 RACK/PANEL INSTRUMENTS

a. Miniservo recorders designed for either rack or panel installation should be mounted upright in a clean, well-lighted location that is free of excessive dust, steam, moisture, smoke, or corrosive fumes. The recorder should not be subjected to extremes of temperature or humidity. In addition, it should not be mounted close to large transformers or near conductors carrying high currents.

b. The recorder chassis (without a case) may be mounted either in a relay rack or panel; or the chassis may be installed in a case which, in turn, is mounted in a rack or panel. The depth of the chassis is 7-1/16" (10-5/8" if equipped with optional rear-connection panel) from the back surface of its mounting flanges and spacer plates[1]. The depth of the case is 10-5/8" from the back surface of its mounting flanges. Space behind mounting flanges (including the mounting panel thickness) must be sufficient to accommodate the appropriate depth dimensions above; also, additional space for wiring may be required. Allow 12" (min.) clearance in front of the panel for chassis insertion/removal and for complete opening of door (if used). The overall dimensions of the recorder chassis are given in Figure 1-2B, while Figure 1-2C gives the overall dimensions of the case with trim bezel or door assembly.

---

[1] Spacer plates supplied only when trim bezel or door assembly is installed on chassis without rack/panel-mount case.

2.2.2.1 RACK-MOUNTING PROCEDURES

a. CHASSIS MOUNTING WITHOUT CASE: A rack/panel adapter is available but, if an existing panel is to be used, it will be necessary to make a panel cutout in a 19" rack panel using dimensions shown in Figure 1-2B.

(1) Insert recorder chassis into front of panel cutout. Place one spacer plate[1] between panel and each chassis-mounting flange. Position plate so that its 4 holes are aligned with the mating holes in chassis flanges.

(2) Secure chassis and spacer plates[1] to panel using four #8-32 screws and nuts (supplied).

(3) If trim bezel is to be installed, align the two plastic projections on back of trim bezel with the tubular speed clips on chassis flanges; then, press bezel into place.

(4) If door assembly is to be installed in lieu of the trim bezel, proceed as follows: Align the door-adapter mounting holes with corresponding holes in chassis flanges, and secure using the four #4-40 x 1/4" screws (supplied). Place door (in open position) on adapter. Slide door top-hinge bracket up and bottom-hinge bracket down so that bracket holes engage the adapter hinge pins. Tighten hinge-bracket screws after both hinges are fully seated.

(5) Secure the panel and recorder in relay rack using suitable hardware.

b. CASE MOUNTING: A rack/panel adapter is available but, if it is desired to use an existing panel, it will be necessary to make a panel cutout in a 19" rack panel using dimensions shown in Figure 1-2C. Drill and tap the four mounting holes for #6-32 screws. Also, drill two 5/32" diameter clearance holes.

(1) Insert case into front of panel cutout until the case-mounting flanges rest against panel. Secure case to panel using a #6-32 screw (supplied) for each of the four mounting holes.

(2) Slide recorder chassis into front of case until the chassis flanges rest against the case flanges. The screw slots in the chassis flanges should be aligned with the corresponding screw holes in case flanges. Secure chassis to the case using two #4-40 x 1/8" screws (supplied).

(3) If either the trim bezel or door assembly is to be installed, refer to step 3 or 4 respectively under paragraph 2.2.2.1a.

(4) Secure the panel and case in relay rack using suitable hardware.

2.2.2.2 PANEL-MOUNTING PROCEDURES

a. CHASSIS MOUNTING WITHOUT CASE: Make a panel cutout using dimensions shown in Figure 1-2B.

(1) Insert recorder chassis into front of panel cutout. Place one spacer plate[1] between panel and each chassis-mounting flange. Position plate so that its 4 holes are aligned with the mating holes in chassis flanges.

(2) Secure chassis and spacer plates[1] to the panel using four #8-32 screws and nuts (supplied).

(3) If either the trim bezel or door assembly is to be installed, refer to step 3 or 4 respectively under paragraph 2.2.2.1a.

b. CASE MOUNTING: Make a panel cutout using dimensions shown in Figure 1-2C. Drill and tap the four mounting holes for #6-32 screws. Also, drill two 5/32" diameter clearance holes.

(1) Insert case into front of panel cutout until the case-mounting flanges rest against panel. Secure case to panel using a #6-32 screw (supplied) for each of the four mounting holes.

(2) Slide recorder chassis into front of case until the chassis flanges rest against the case flanges. The screw slots in the chassis flanges should be aligned with the corresponding screw holes in case flanges. Secure chassis to the case using two #4-40 x 1/8" screws (supplied).

(3) If either the trim bezel or door assembly is to be installed, refer to step 3 or 4 respectively under paragraph 2.2.2.1a.

2.3 ELECTRICAL CONNECTIONS

The internal wiring diagram furnished in this manual identifies all external terminal connections for signal input, as well as for the wiring of standard options that may be supplied with the recorder. To gain access to the rear-connection panel (if used), loosen the four screws securing the panel cover, lift the cover upward, and remove it from the rear of the instrument.

2.3.1 BENCH-TOP INSTRUMENTS

Input power and accessory ratings will be specified on a nameplate located on the rear panel. These ratings are also listed on the Data Sheet. Bench-top recorders have signal input jacks on the front panel.

---

[1] Spacer plates supplied only when trim bezel or door assembly is installed on chassis without rack/panel-mount case.

2.3.1.1 POWER CONNECTIONS

Power to operate the bench-styled recorder is conducted through a permanently attached three-wire power cord extending from the rear of the case. An input-power fuse is located on the rear panel. It is recommended that an external ground connection be made to the instrument--preferably through the power cord. The ground input jack (⏚) on the front panel and the power cord ground lead are internally connected to the recorder chassis; however, an external ground should be established at only one point on the instrument.

2.3.1.2 ANALOG SIGNAL CONNECTIONS

The analog signal must be connected to the front panel input jacks (Figure 2-1C). Refer to paragraph 2.3.3 for suggested input signal shielding and grounding techniques.

> CAUTION: Common mode voltage *must not* exceed a maximum of 150V DC.

2.3.2 RACK/PANEL INSTRUMENTS

Input power and accessory ratings will be specified on a nameplate located on the chassis left-rear side. These ratings are also listed on the Data Sheet. All rack/panel Miniservo recorders mounted in a case have a connection panel (CP101) at the rear of the unit. Recorders without a case may be optionally equipped with a rear- connection panel.

2.3.2.1 POWER CONNECTIONS

A three-wire power cord should be connected to the rear-connection panel, or to terminal board TB101 if the connection panel is not used (Figure 2-1). An input-power fuse is located on rear-connection panel. It is recommended that an external ground connection be made to the instrument--preferably through the power cord. The GND input terminal on the rear-connection panel (or ground terminal on TB101 if rear connection panel is not used) is internally connected to the recorder chassis; however, an external ground should be established at only one point on the instrument.

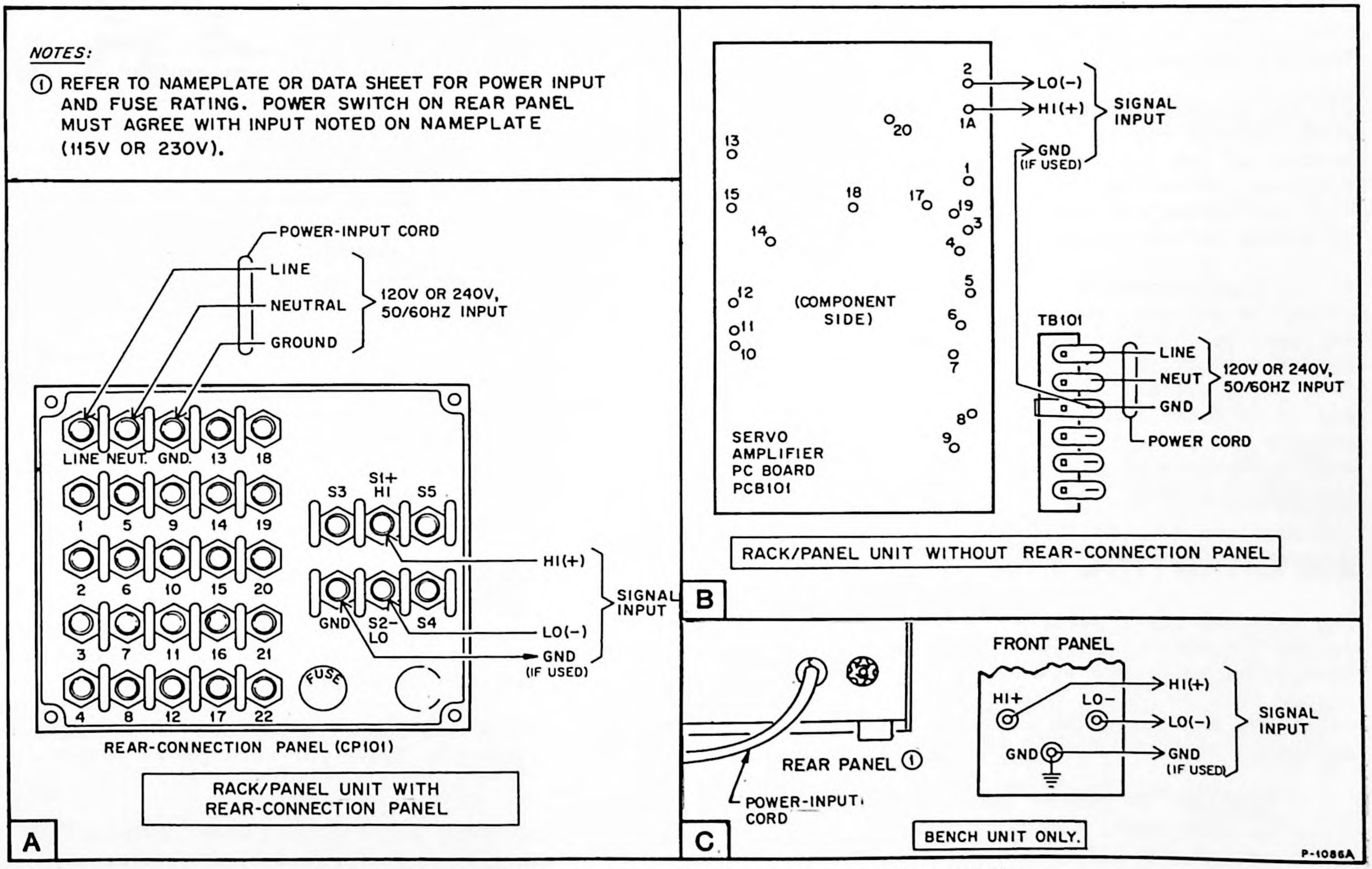


Figure 2-1. Power and Signal-Connection Points.

2.3.2.2 ANALOG SIGNAL CONNECTIONS

a. If the recorder is equipped with a rear-connection panel (CP101), use signal-connection points shown in Figure 2-1A.

b. Recorders without a rear-connection panel must have the analog signal connected directly to pin posts located on the servo-amplifier board (PCB101) as shown in Figure 2-1B. For connecting to pin posts, mating female lead connectors are available from Esterline Angus under Part Number KPC21F.

> CAUTION: Common mode voltage *must not* exceed a maximum of 150V DC.

c. Refer to paragraph 2.3.3 for suggested input signal shielding and grounding techniques.

2.3.3 SIGNAL SHIELDING AND GROUNDING TECHNIQUES

a. For most applications, signal input connections may be made with a single-wire shielded cable or unshielded leads as shown in Figure 2-2A & B. For low-level signals in "noisy" area, however, a two-wire shielded cable is recommended (see wiring examples in Figure 2-2C).

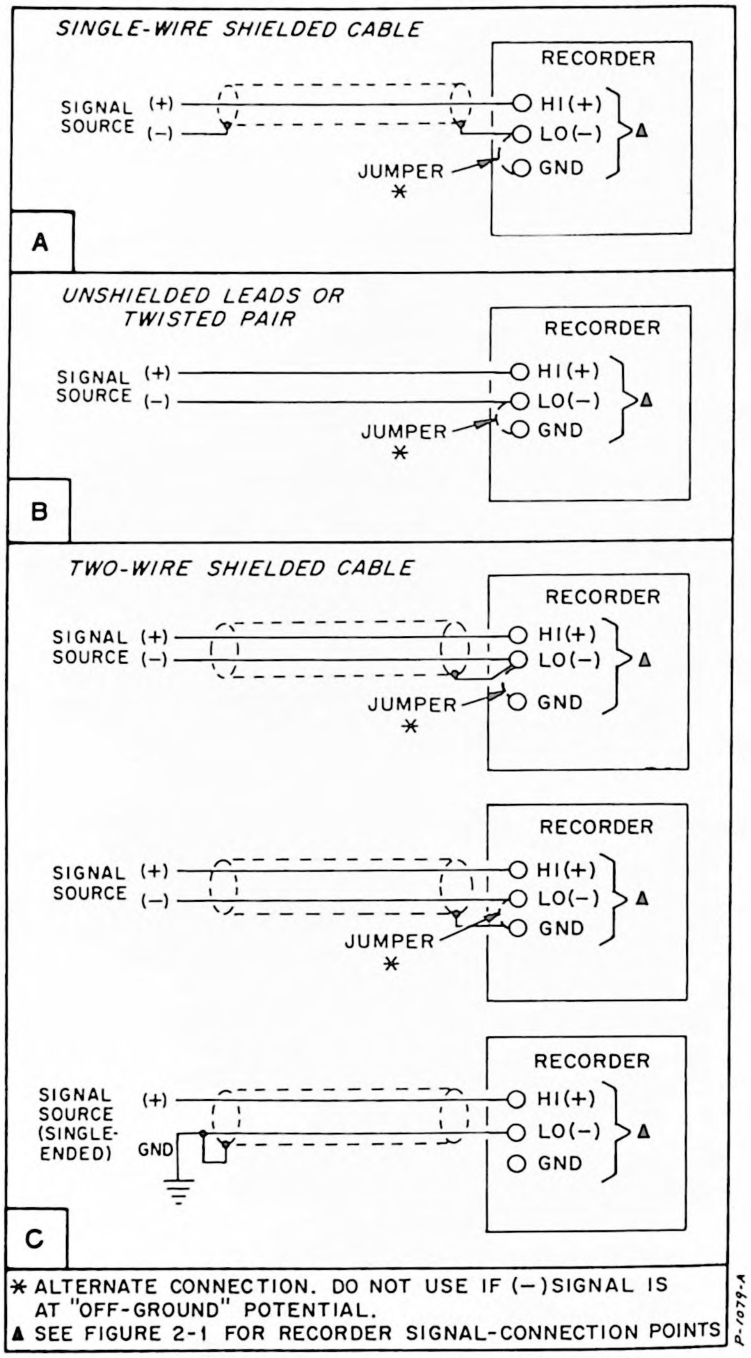
b. The presence of external interference (or stray pickup) may be indicated by a slight vibration of the pen, zero shifting, excessive deadband, or any combination of these effects. Such conditions can usually be eliminated by use of proper shielding and grounding techniques.

c. In applications where the source of stray pickup is unknown, the ideal operating condition may best be found by experimenting with the different connection configurations shown in Figure 2-2. If unsatisfactory operation still exists and it is established that relatively high AC signals are present, it may be necessary to insert a low-pass RC filter across the output of the signal source.

2.4 CHARTING PROCEDURES

Two types of chart paper are available for use in the Miniservo recorders -- roll and Z-fold. Rack/Panel recorders without a door may use either roll or Z-fold charts, while rack/panel recorders equipped with a door and bench-top recorders must use Z-fold charts only.

> CAUTION: To remove scaleplate, grasp at both ends, carefully swing bottom upward, and lift out with both hands.



* ALTERNATE CONNECTION. DO NOT USE IF (−)SIGNAL IS AT "OFF-GROUND" POTENTIAL.

▲ SEE FIGURE 2-1 FOR RECORDER SIGNAL-CONNECTION POINTS

Figure 2-2. Signal Shielding & Grounding.

(1) To install a chart in the recorder, turn recorder power off, swing scaleplate upward and remove. Raise pen lifter lever located at left end of chart-drive roller. Pull drawer assembly forward against its stops.

(2) Follow steps in 2.4.1 for bench-top instruments or steps in 2.4.2 for rack/panel instruments.

(3) After chart is in place, lower pen lifter lever and replace scaleplate by inserting top

edge in first; then, swing plate downward until it snaps into position. Apply power to recorder.

2.4.1 BENCH-TOP INSTRUMENTS

2.4.1.1 Z-FOLD CHARTING

(1) Grasp center wedge attached to hinged baffle, and pivot baffle downward.

(2) Place chart supply in paper-supply compartment so that elongated drive holes are toward left side of recorder, and printed side of chart is toward rear of recorder.

(3) Pull up a few inches of chart from supply and insert end of chart between loading chute and drive roller as shown in Figure 2-3A.

(4) Thread chart over top of drive roller and under chart hold-down/tear-off bar by rotating thumbwheel on right end of drive roller until leading edge of chart is just behind tear-off bar. See that roller pins engage the perforations in chart paper at both edges.

(5) If any chart paper is protruding from paper-supply compartment, carefully fold it back into its original configuration in the compartment. Pivot baffle upward, and snap into position by pressing on both front-top corners.

(6) Rotate thumbwheel downward until chart enters the drawer assembly and begins to fold in the manner shown in Figure 2-3A. If chart does not automatically start to fold properly at its first fold, manually position first fold to ensure correct folding. Allow at least three folds to accumulate in the drawer. This completes chart installation.

(7) A 1/8" wide, blue line starting approximately one meter (36") from end of chart in left-hand margin gives warning that end of chart is near.

2.4.2 RACK/PANEL INSTRUMENTS

2.4.2.1 ROLL CHARTING

(1) Refer to Figure 2-3B and remove chart accumulation plate(if used) and folding wedge as follows:

(a) Loosen the two #4 self-tapping screws which hold accumulation plate to the drawer, and pull plate forward from the two retaining screws.

(b) Remove the two #4-40 x 1/8" screws securing wedge to chart hold-down assembly and remove wedge.

> NOTE: Do not discard accumulation plate and folding wedge after removing. These parts must be reinstalled if Z-fold mode of charting is used. See "Z-Fold Charting" in paragraph 2.4.2.2.

(2) Place supply roll in front paper-supply compartment so that elongated drive holes are toward left side of recorder.

(3) Pull a few inches of chart from supply roll, and insert end of chart between mylar threading chute and drive roller as shown in Figure 2-3B.

(4) Thread chart over top of drive roller and under chart hold-downs by rotating thumbwheel on right end of drive roller. See that roller pins engage the perforations in chart paper at both edges. Close drawer assembly. Rotate thumbwheel downward until end of chart is below top edge of drawer. This completes chart installation.

> NOTE: A 1/8" wide blue line starting approximately one meter (36") from end of chart in left-hand margin gives warning that end of chart is near.

2.4.2.2 Z-FOLD CHARTING

(1) Place chart supply in rear paper-supply compartment so that elongated drive holes are toward left side of recorder, and printed side of chart is toward rear of recorder. Slide chart supply into paper compartment through opening on right side.

> NOTE: If accumulation plate and folding wedge have been previously removed for operation of the roll-charting mode (paragraph 2.4.2.1), reinstall these parts as shown in Figure 2-3C.

(2) Pull up a few inches of chart from supply and insert end of chart between mylar threading chute and drive roller as shown in Figure 2-3C.

(3) Thread chart over top of drive roller and under chart hold-downs and folding wedge by rotating thumbwheel on right end of drive roller. See that roller pins engage the perforations in chart paper at both edges. Close drawer assembly.

(4) Rotate thumbwheel downward until chart enters the front paper compartment and begins to fold in the manner shown in Figure 2-3C. If chart does not automatically start to fold properly at its very first fold, manually position first fold to ensure correct folding. Allow at least three folds to accumulate in the front paper compartment.

(5) A 1/8" wide, blue line starting approximately one meter (36") from end of chart in left-hand margin gives warning that end of chart is near.

2.5 INKING PROCEDURES

The disposable pen module contains an integral ink supply and is furnished in the service kit. To activate the analog inking system, remove power and input signals; then, grasp scaleplate at both ends, carefully swing bottom upward, and lift out. Remove red protective cap from pen tip, face pen tip down, and insert module straight back into cartridge holder. Priming of the pen is not necessary. Use both hands to replace the scaleplate. Insert top edge first; then swing plate carefully downward until it snaps into position. Reconnect power and signal.

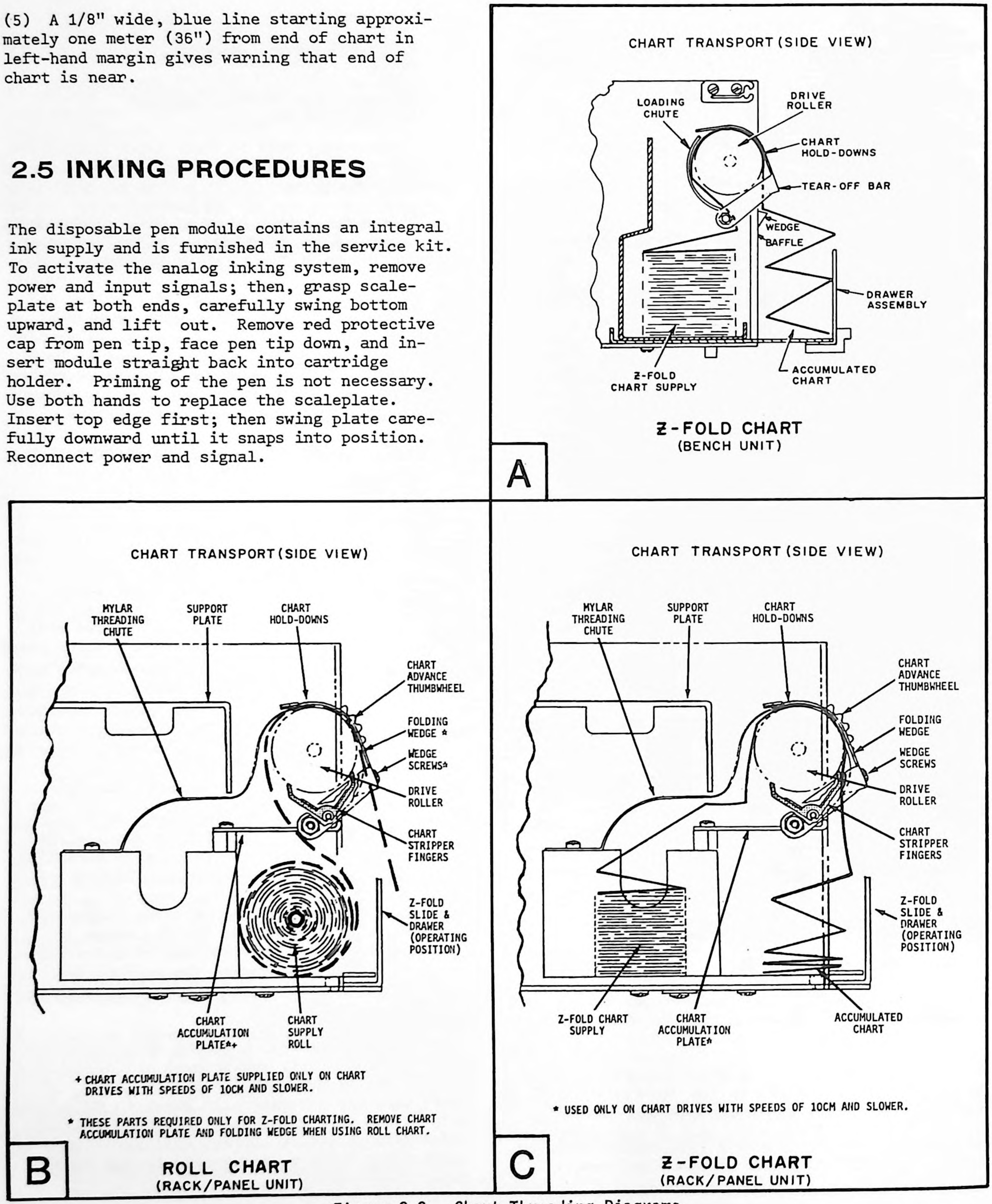


Figure 2-3. Chart Threading Diagrams.

SECTION 3--OPERATION

3.1 FRONT PANEL CONTROLS

Operating controls for bench-top and rack/panel Miniservo recorders vary as illustrated in Figure 3-1. These variations are delineated in the following paragraphs.

3.1.1 BENCH AND RACK/PANEL UNITS

a. CHART ADVANCE (THUMBWHEEL): This mechanical adjustment is provided so that the operator can advance the chart paper manually. Rotating the wheel downward over-rides the internal drive system and propells the chart forward. This control should always be used when charting the instrument.

b. PEN LIFT (LEVER): The small metal arm located at the left end of the scaleplate is a pen lifter lever. This device permits the operator to raise or lower the recording pen as desired. To raise the pen from the chart, merely move the lever arm upward. The pen can be lowered to its recording position by moving the lever downward.

3.1.2 BENCH-TOP INSTRUMENTS ONLY

a. POWER SWITCH (S101): This is a two-position slide switch that controls AC power to both servo and chart-drive systems. To energize the recorder, move the switch to its "ON" position. Always place the switch in its "OFF" position when recorder is not in use, or when charting, inking or servicing the unit.

b. CHART SPEED SELECTOR (S301): This nine-position rotary switch is provided on the front panel for the multi-speed feature. It offers the operator a selection of eight chart speeds, and it may be rotated in either direction with power on or off. To stop the chart paper, place the switch in its "OFF" position (fully counterclockwise.

c. SPAN SWITCH (S102): An eleven-position rotary switch is supplied with the multi-span feature. This front-panel switch is used to select the signal input range of the instrument and indicates full-span calibration. The switch assembly also includes an inner concentric control (R110). This screwdriver adjustment provides a zero pen positioning over 100% of the chart span.

3.2 SERVO ADJUSTMENTS

a. All Miniservo recorders are carefully set up for normal operating standards before leaving the factory; however, certain servo system adjustments are provided to satisfy various field applications and for calibration purposes. These adjustments include Zero, Gain, and Span, which are miniature potentiometers that mount on an internal PC board. The controls are adjustable with a small screwdriver through access holes as illustrated in Figure 3-1.

b. ZERO ADJUST (R11): This control is used to inject an offset voltage into the measuring system which will position the recording pen at chart zero when no signal is applied. It provides a zero shift of approximately ±10% of chart span.

> NOTE: Zero adjust (R11) is omitted on bench-top instruments.

c. GAIN ADJUST (R15): Servo stiffness (deadband) is determined by the setting of this control. It establishes overall amplification through a signal feedback loop in the servo system. For maximum stability, the control should be adjusted for only maximum specified deadband.

d. SPAN ADJUST (R2): The Span control regulates the precise amount of reference supply voltage that is applied across the feedback pot. It de-

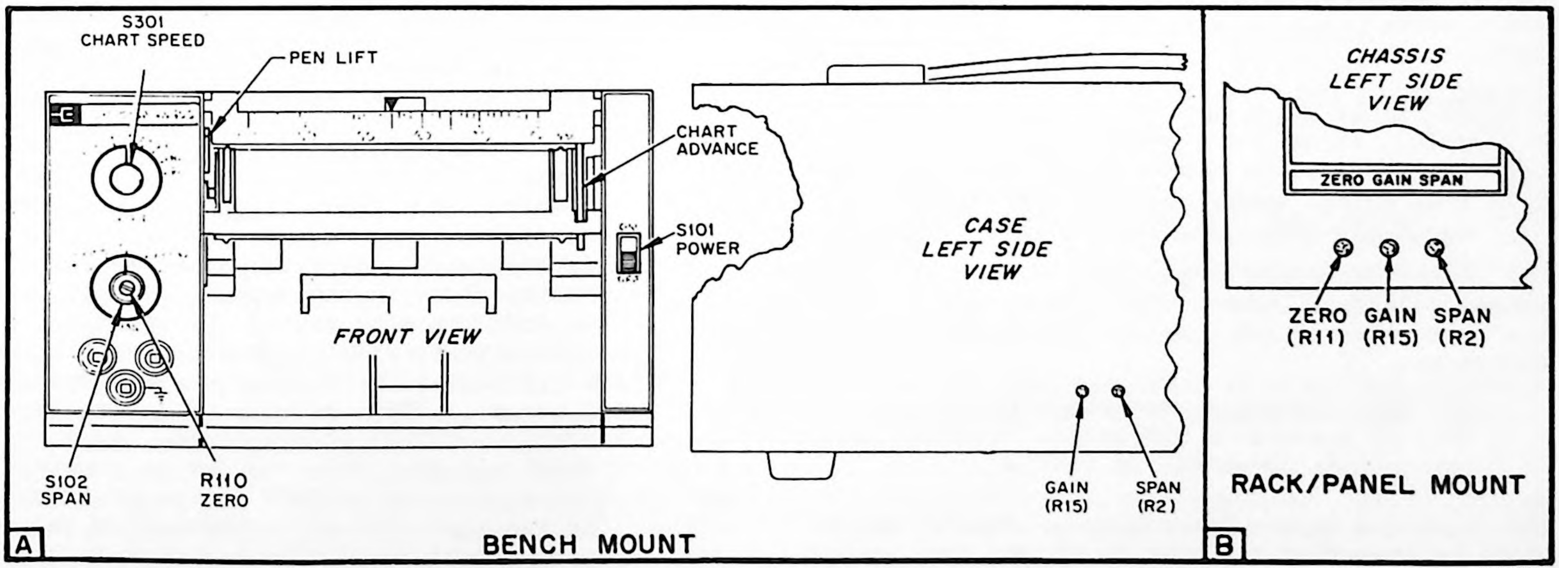


Figure 3-1. Location of Controls and Adjustments.

termines the accuracy of full-span deflection, and should therefore be adjusted only during calibration procedures. This adjustment provides a shift at F.S. of approximately 10% of chart span.

> NOTE: No damping adjustment is required. A dynamic damping circuit has been built into the servo amplifier for optimum response characteristics.

3.3 OPERATING PROCEDURES

The following instructions assume that power is connected to the instrument, chart paper is installed, and that the inking system is ready for operation.

> CAUTION: Internal servo adjustments are pre-set and should not be disturbed unless otherwise specified.

(1) Without input signal applied, apply power to recorder. A 10-minute warm-up period is recommended for amplifier stabilization.

> NOTE: If multi-speed chart drive feature[1] is supplied, place selector in slowest speed position to conserve paper.

(2) Using both hands, carefully rotate scaleplate upward and out; then, lower recording pen onto chart by moving pen lift lever down.

(3) Connect shorting jumper across "HI" and "LO" signal inputs.

> NOTE: If multi-span feature[1] is supplied, place SPAN switch in appropriate position for intended measurement.

(4) Recording pen should come to rest on zero reference line of chart. If it does not, carefully reset ZERO adjust (R11, Figure 3-1). Use small screwdriver or alignment tool for adjustment.

> NOTE: If multi-span feature[1] is supplied, adjust Zero pot (R110, Figure 3-1) accessible through center of SPAN switch knob. To elevate zero, see MULTI-SPAN ZERO instructions.

(5) Remove shorting jumper and connect analog source to signal inputs. If options are supplied, see that selector switches are in appropriate positions.

> CAUTION: Internal over-range protection is limited to ±10 volts. Maximum common-mode potential is 150V DC.

(6) Recorder is now operational. Replace scaleplate by inserting top edge in first; then, swing plate downward until it snaps into position.

> NOTE: If recording accuracy is not within acceptable tolerance, refer to calibration instructions.

3.4 MULTI-SPAN ZERO[1]

a. When a recorder is equipped with the multispan feature, Zero potentiometer (R110) is included as part of the SPAN switch assembly. This front-panel screwdriver adjustment affords the operator zero pen positioning over the entire chart. Electrical zero can be shifted up-scale (elevated) from chart or scale "O" to 100% of the recording span; therefore, the MINISERVO can be adjusted to record negative or both positive and negative input signals.

b. Electrical zero may be elevated by the following procedure:

(1) Remove analog source and connect shorting jumper across "HI" and "LO" signal inputs.

(2) Place SPAN switch (S102) in desired span position, turn on power switch (S101), and permit instrument to warm up for ten minutes.

(3) Determine desired zero pen position on chart or scale. Lower-end value of input signal range equals minimum amount of zero elevation required--disregarding negative sign of signal.

> NOTE: If desired scale calibrations are not directly proportional to selected span, calculate equivalent percentage point on scale.

(4) Using small screwdriver, carefully adjust Zero (R110) until recording pen moves up-scale to point determined in step (3). Adjustment is accessible through hole in center of SPAN knob.

(5) Remove shorting jumper and connect signal source to be measured. Instrument will now record analog inputs over offset range selected.

c. EXAMPLE: Assume an analog source having maximum signal deviations from -13MV to +65MV. The total desired measurement range is thus 78MV. To encompass this signal range, a recorder span of 100MV is selected. Since the selected span is 22MV greater than the anticipated signal range, 11MV may be added to each end of the range so that all measurements will be centered within the chart span. Adding 11MV to the lower-end value of the signal range (-13MV), results in a total required elevation of 24MV (disregarding sign). Zero pot (R110) is then adjusted for an elevated pen position equivalent to 24MV on the chart or scale. The recorder will now operate over the desired input signal range with a full-span calibration of from -24MV to +76MV.

---

[1] Available on bench-top instruments only.

SECTION 4--MAINTENANCE

4.1 GENERAL

The MINISERVO, designed for long trouble-free operation, should require little attention in the field. Periodic maintenance schedules should be established and followed, however, to ensure optimum performance. Where extreme temperatures or contaminated atmospheres prevail, maintenance should be performed more often. Since frequency of use and environmental conditions will vary with applications, maintenance scheduling is left to the discretion of the user. Routine maintenance procedures will primarily entail a complete visual inspection and cleaning. Keeping a simple record of component replacements will be a handy reference during inspection, and will ensure a ready reserve of expendable items to be maintained--such as chart paper and pen modules.

> WARNING: Prior to servicing or cleaning activities, always remove AC power and any other wiring that is potentially dangerous.

4.2 INSPECTION

A complete visual inspection of the instrument should be made at each scheduled maintenance period to detect the possible onset of a malfunction. At that time, check for low chart supply, accumulation of dirt, damaged or loose hardware, shorted or broken wiring, and loose connections. Also check the reserve of charts and pen modules to assure that an adequate supply is on hand.

4.3 CLEANING

a. Regardless of the precautions taken, dirt and dust will enter the recorder chassis area; therefore, periodic cleaning of exposed components within the instrument will be necessary. Always keep the pen tip free of lint and dried ink. To prevent dry-out, replace red cap on pen tip if recorder will remain inactive for more than 24 hours.

b. Light dirt marks can be removed from case surfaces, scaleplate, and front control panel[1] with a damp, lint-free cloth or sponge. Esterline Angus recording ink is water based and can be removed with a wet cloth. Heavier dirt smudges can be removed with any commercially-available liquid detergent; however, *Do Not* use harsh solvents as they may damage certain finishes. Dust and other dry accumulations can be removed from within the recorder with a soft-bristled brush or low-vacuum system. Under normal operating conditions, recorder lubrication will not be necessary in the field. *Do Not* lubricate the pen module bearing or its guide rod, under any circumstance

> CAUTION: Exercise care when cleaning to avoid disturbing electrical wiring and alignment of mechanical parts.

4.4 CALIBRATION

Recorder calibration can be checked by a direct comparison with a known-accurate standard. The validity of such a test, however, depends upon the accuracy of the reference source--which should be considerably better than accuracy requirements of the recorder. To calibrate the MINISERVO, refer to Figure 3-1 for the location of adjustments and proceed with the following steps:

(1) Disconnect analog source and connect output of precision voltage standard* to recorder input terminals. (*Esterline Angus Model V-2000 or equivalent.)

(2) Set standard for zero voltage output, apply power to recorder, and permit equipment to warm up for at least ten minutes.

> NOTE: Chart paper should be in motion for all of the following adjustments. If multi-span feature[1] is supplied, place span switch is its mid position.

(3) Adjust Zero pot R11 (or R110[1]) until recording pen point comes to rest precisely on zero reference line of chart.

(4) Set standard for a DC voltage output equal to full-span calibration of recorder.

(5) Adjust Span pot (R2) until pen point comes to rest precisely on full-scale reference line of chart.

> NOTE: On single-span units, a slight interaction may occur between Zero and Span adjustments; therefore, repeat steps 3, 4 and 5 until desired accuracy is achieved.

(6) Adjust Gain pot (R15) to a minimum clockwise setting that produces a deadband within .2% of span.

(7) Calibration is now complete. Remove voltage standard, reconnect analog source, and check recorder operation.

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[1] Available on bench-top instruments only.

4.5 DISASSEMBLY

a. All components of the Miniservo recorder are accessible for inspection and servicing by removing the internal chassis assembly from the instrument case or rack panel.

b. Basic chassis construction and the location of functional parts are shown in Figure 4-1. The servo-amplifier board and the stepper-drive board (bench-top units only) are replaceable as complete subassemblies. Other components such as the servo motor, feedback pot, and chart-drive motor are also replaceable in the field.

4.5.1 BENCH-TOP RECORDERS

To expose the chassis, proceed with the following steps:

(1) Disconnect power cord from AC source and remove signal wiring from front-panel jacks.

(2) Remove two screws from each side of base pan and lift off top cover.

4.5.2 RACK/PANEL RECORDERS WITHOUT CASE

To remove chassis from rack or panel, proceed with the following steps:

(1) Disconnect power cord from AC source.

(2) If rear-connection panel is used, follow step (a) below; if connection panel is not used, proceed to step (b).

(a) Loosen 4 screws securing terminal cover to rear-connection panel. Lift cover upward and remove; then, disconnect external signal wiring.

(b) Disconnect external signal wiring from pin posts on servo amplifier PC board (PCB101).

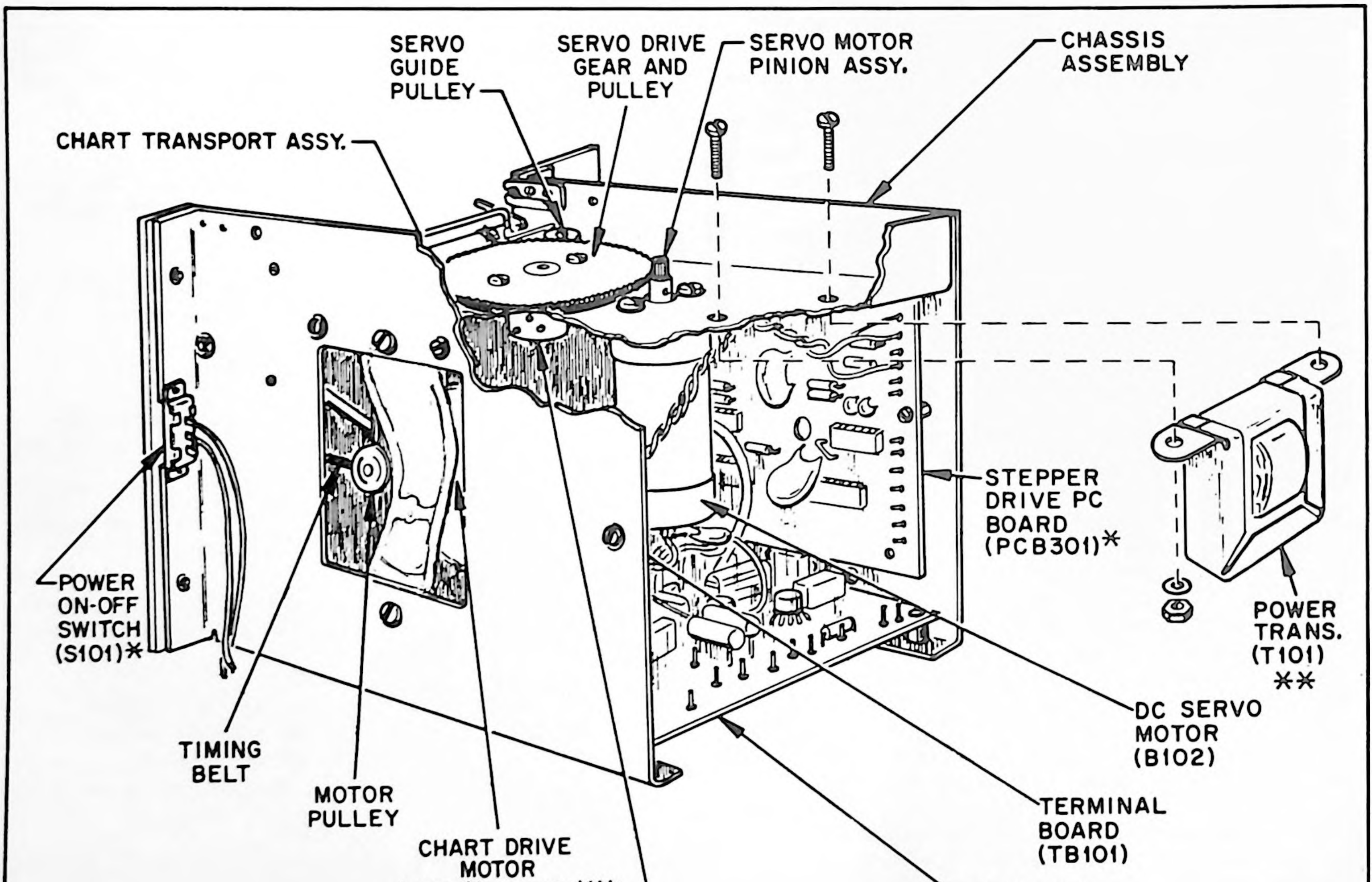

Figure 4-1. Major Components of MINISERVO Chassis Assembly.

(3) If recorder is equipped with door assembly, follow step (a) below; if trim bezel is used in lieu of door assembly, proceed to step (b).

(a) Open door, loosen 2 self-tapping screws (#4) securing door hinge brackets, slide brackets off hinge pins, and remove door. Remove 4 screws (#4-40 X 1/4") securing door adapter to chassis, and pull adapter from chassis.

(b) Carefully pull or pry the trim bezel away from the panel until the two plastic projections on back of bezel disengage from the chassis speed clips, and remove bezel.

(4) Remove 4 screws and nuts (#8-32) securing chassis to panel. The 2 spacer plates[1] will slide from behind chassis-mounting flanges.

(5) Remove chassis by carefully sliding out assembly from *front* of panel. Guide power cord through opening in panel.

4.5.3 RACK/PANEL RECORDERS WITH CASE

The chassis can be removed from its case while leaving case installed in rack or panel. To remove chassis from case, proceed with the following steps:

(1) Disconnect power cord from AC source.

(2) Loosen 4 screws securing terminal cover to rear-connection panel. Lift cover upward and remove; then, disconnect external signal wiring.

(3) If recorder is equipped with door assembly, follow step (a) below; if trim bezel is used in lieu of door assembly, proceed to step (b).

(a) Open door, loosen 2 self-tapping screws (#4) securing door hinge brackets, slide brackets off hinge pins, and remove door.

(b) Carefully pull or pry the trim bezel away from the panel until the two plastic projections on back of bezel disengage from chassis speed clips, and remove bezel.

(4) Remove 2 screws (#4-40 X 1/8") securing chassis to case. If door assembly is used, the door adapter may remain attached to the chassis, since the 2 chassis-mounting screws are accessible through holes in the door adapter.

(5) Remove chassis and door adapter (if used) by carefully sliding out assembly from *front* of panel. Guide power cord through opening in panel.

4.6 SHUTDOWN

If the recorder is to remain inactive for more than 30 days, disconnect AC power and remove pen cartridge module. If cartridge is to be retained, place red protective cap over pen tip. If instrument is to be transported for a long distance, follow factory packing procedures.

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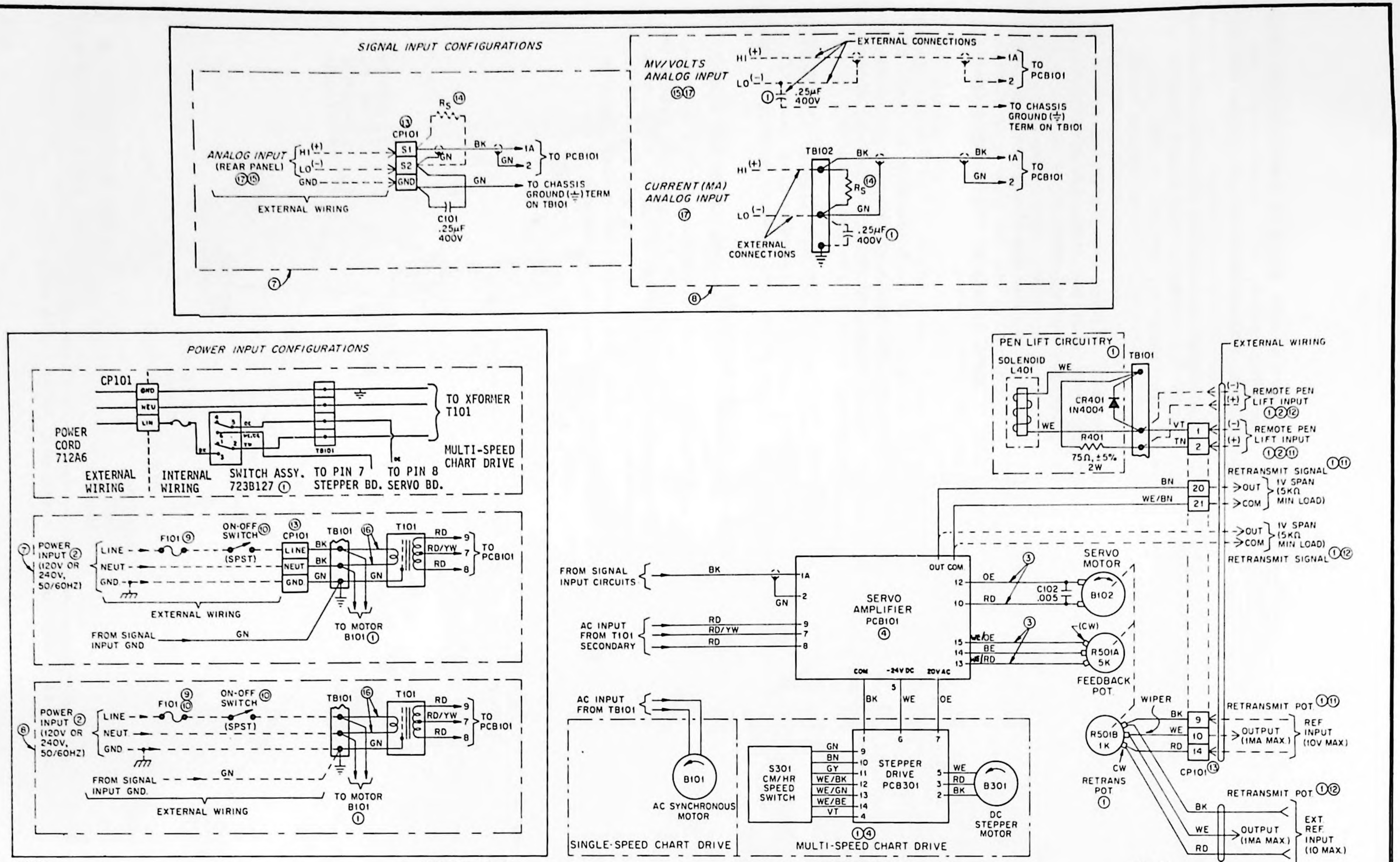
[1] Spacer plates supplied only when trim bezel or door assembly is installed on chassis without rack/panel-mount case.



NOTES:

① SELECTABLE OR OPTIONAL FEATURE.

② REFER TO DATA SHEET FOR RATING.

③ WIRING FOR RIGHT-HAND ZERO SHOWN. REVERSE CONNECTIONS FOR LEFT-HAND ZERO.

④ REFER TO SEPARATE SCHEMATIC DIAGRAM.

⑦ FOR RACK/PANEL-MOUNT UNIT WITH REAR CONNECTION PANEL (CP101).

⑧ FOR RACK/PANEL-MOUNT UNIT WITHOUT REAR CONNECTION PANEL (CP101).

NOTES (CONT'D.):

⑨ 1/4A FOR 120V INPUT; 1/8A FOR 240V INPUT.

⑩ SUPPLIED BY USER.

⑪ WIRING FOR RACK/PANEL-MOUNT UNIT WITH REAR CONNECTION PANEL (CP101).

⑫ WIRING FOR RACK/PANEL-MOUNT UNIT WITHOUT REAR CONNECTION PANEL (CP101).

⑬ REAR CONNECTION PANEL (CP101) IS STANDARD ON RACK/PANEL-MOUNT UNIT WITH CASE. CONNECTION PANEL IS OPTIONAL ON RACK/PANEL-MOUNT UNIT WITHOUT CASE.

⑭ FOR CURRENT MEASUREMENT SPANS ONLY. SEE DATA SHEET FOR RESISTANCE VALUE.

NOTES (CONT'D.):

⑮ EXTERNAL VOLTAGE DIVIDERS ARE REQUIRED FOR F.S. SPANS ABOVE 1 VOLT.

⑯ BLACK LEADS FOR 120V INPUT; WHITE LEADS FOR 240V INPUT.

⑰ REFER TO DATA SHEET FOR ACTUATION AND MEASURING RANGE.

LEGEND:

⏚ EXTERNAL BUILDING GROUND.

⏚ CHASSIS GROUND.

Figure 4-2. Internal Wiring Diagram for Rack/Panel-Mount Recorder.

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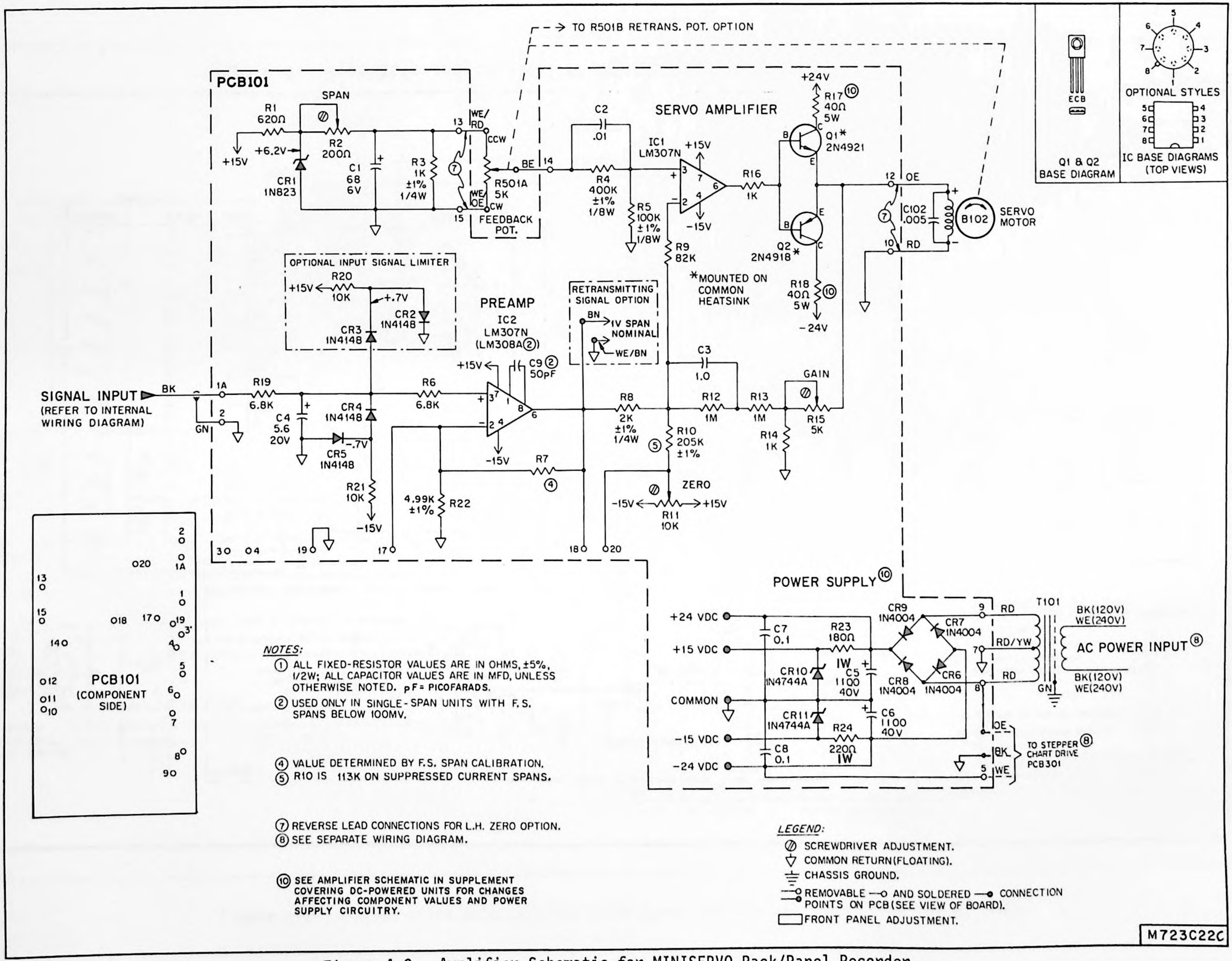


NOTES:

① ALL FIXED-RESISTOR VALUES ARE IN OHMS, ±5%, 1/2W; ALL CAPACITOR VALUES ARE IN MFD, UNLESS OTHERWISE NOTED. pF = PICOFARADS.

② USED ONLY IN SINGLE-SPAN UNITS WITH F.S. SPANS BELOW 100MV.

④ VALUE DETERMINED BY F.S. SPAN CALIBRATION.

⑤ R10 IS 113K ON SUPPRESSED CURRENT SPANS.

⑦ REVERSE LEAD CONNECTIONS FOR L.H. ZERO OPTION.

⑧ SEE SEPARATE WIRING DIAGRAM.

⑩ SEE AMPLIFIER SCHEMATIC IN SUPPLEMENT COVERING DC-POWERED UNITS FOR CHANGES AFFECTING COMPONENT VALUES AND POWER SUPPLY CIRCUITRY.

LEGEND:

Ø SCREWDRIVER ADJUSTMENT.

▽ COMMON RETURN (FLOATING).

⏚ CHASSIS GROUND.

REMOVABLE —o AND SOLDERED —● CONNECTION POINTS ON PCB (SEE VIEW OF BOARD).

☐ FRONT PANEL ADJUSTMENT.

Figure 4-3. Amplifier Schematic for MINISERVO Rack/Panel Recorder.

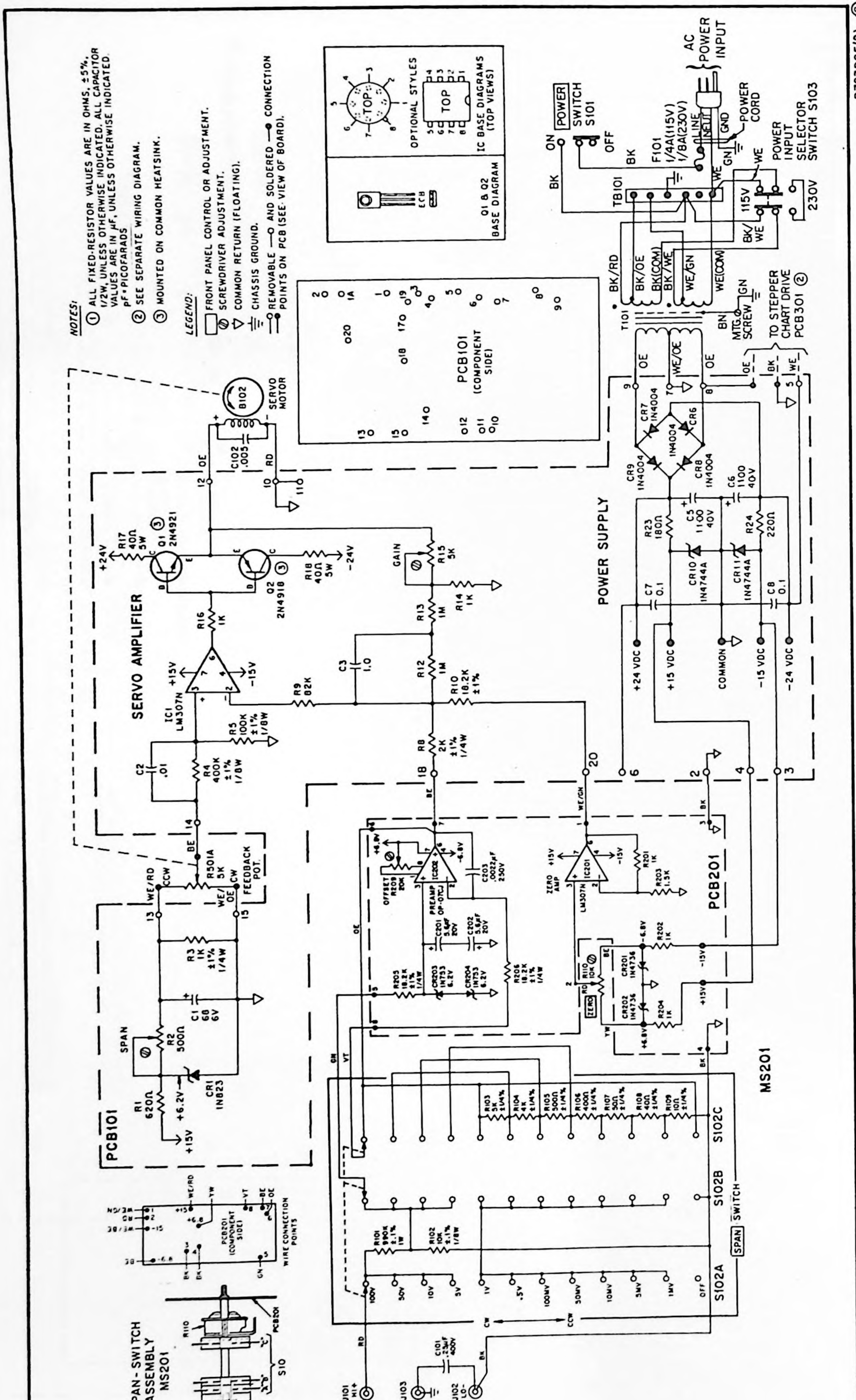
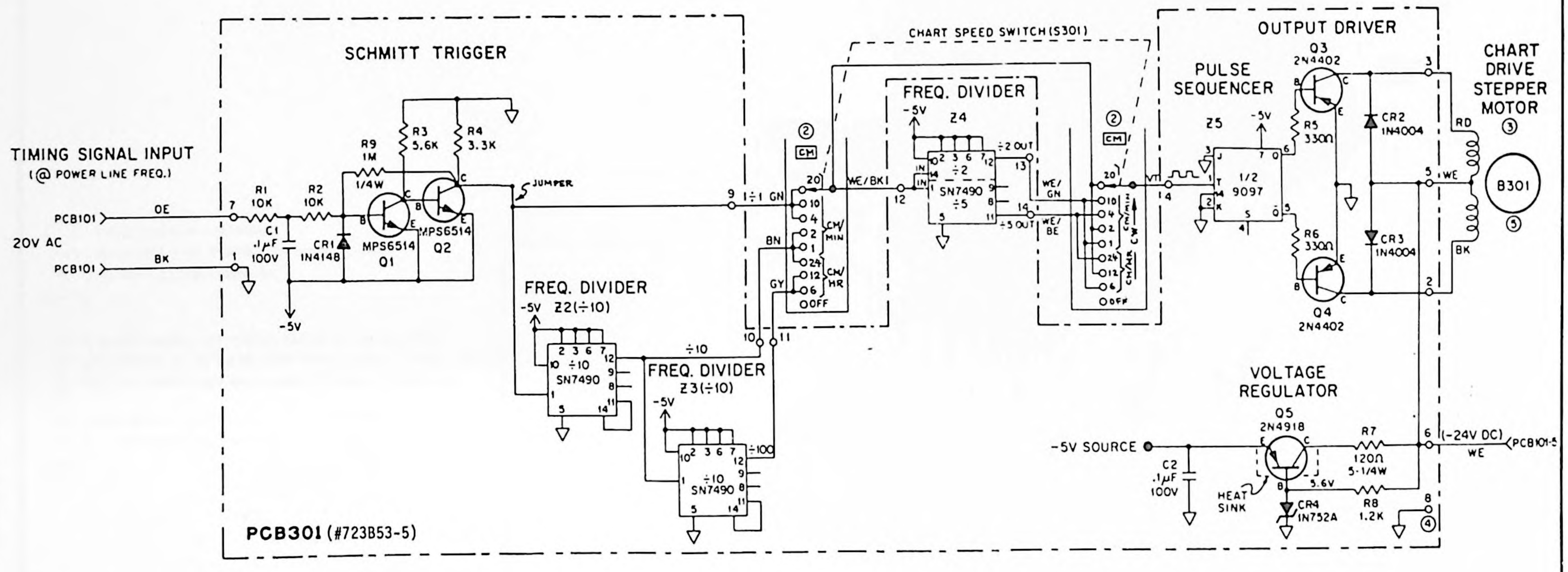


Figure 4-4. Schematic and Internal Wiring Diagram for Bench-top Recorder.



NOTES:

① ALL FIXED RESISTOR VALUES ARE IN OHMS ±5%, 1/2W, UNLESS OTHERWISE NOTED.
② CHART SPEEDS SHOWN ARE FOR 50HZ OR 60HZ OPERATION.

③ 30 Hz (20 pps) INTO MOTOR MOVES CHART AT 20 CM/MIN (1200 CM/HR).
④ PCB TERMINAL 8 NOT TO BE USED FOR EXTERNAL COMMON CONNECTION.
⑤ STEPPER MOTOR: A.W. HAYDON SERIES 45100 (0-80pps).

LEGEND:

- ▽ COMMON RETURN (FLOATING).
- —○ REMOVABLE WIRE CONNECTION POINT ON PCB.
- ▭ FRONT PANEL ADJUSTMENT.

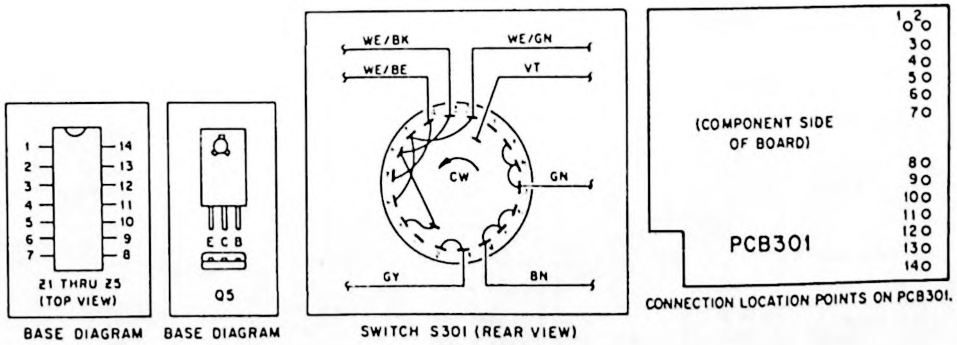


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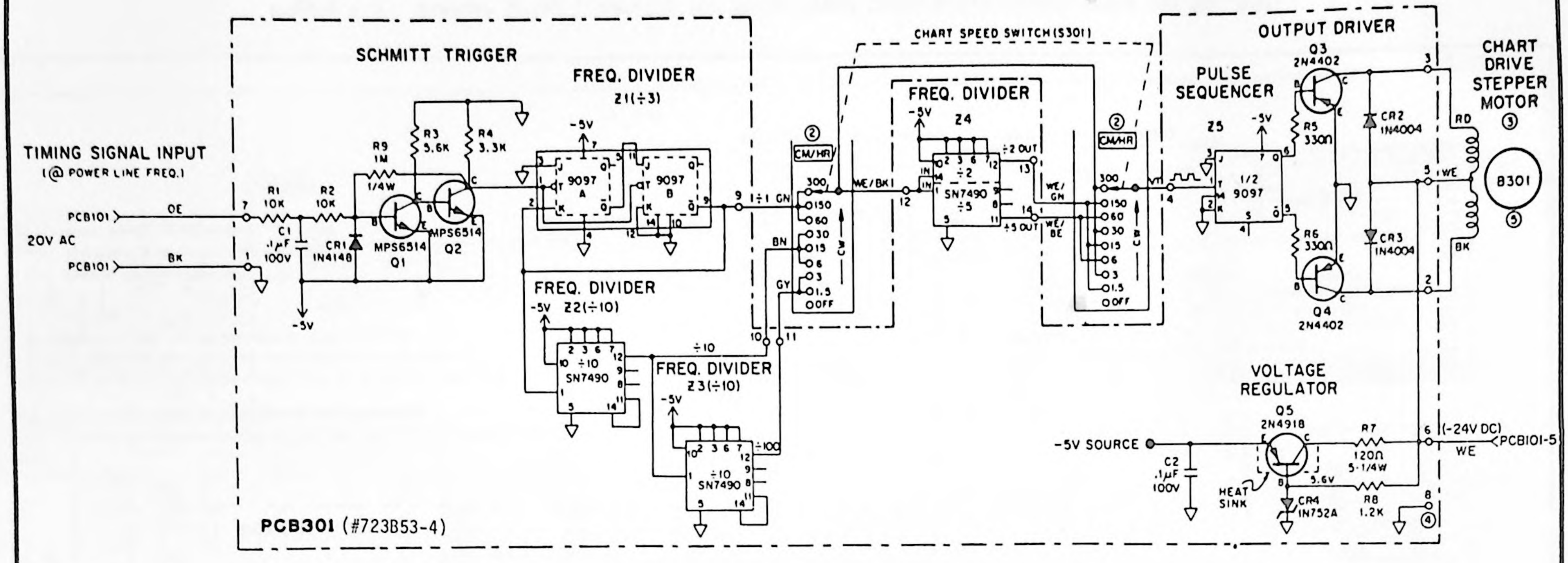
Figure 4-5. Stepper Drive Schematic for Multi-Speed Chart Drive (Chart Drive Key No. 830).



NOTES:

① ALL FIXED RESISTOR VALUES ARE IN OHMS ±5%, 1/2W, UNLESS OTHERWISE NOTED.
② CHART SPEEDS SHOWN ARE FOR 50HZ OR 60HZ OPERATION.

③ 10 CYCLES (20pps) INTO MOTOR MOVES CHART AT 300 CM/HR.
④ PCB TERMINAL 8 NOT TO BE USED FOR EXTERNAL COMMON CONNECTION.
⑤ STEPPER MOTOR: A.W. HAYDON SERIES 45100 (0-20pps).

LEGEND:

▽ COMMON RETURN (FLOATING).
—○ REMOVABLE WIRE CONNECTION POINT ON PCB.
▭ FRONT PANEL ADJUSTMENT.

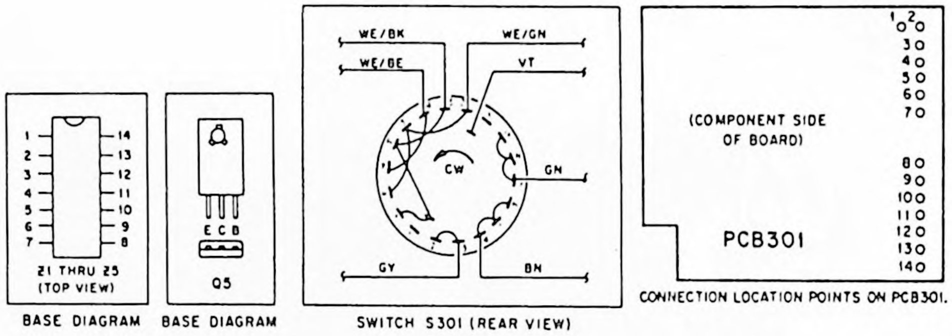


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Figure 4-6. Schematic of Optional Stepper Drive (Chart Drive Key No. 815).

SECTION 5--ILLUSTRATED PARTS BREAKDOWN

5.1 PARTS TABLES

a. Each parts table in the following section covers a major assembly or group of related components used in the construction of MINISERVO recorders. Illustrations accompany each parts list to assist the user in obtaining a correct replacement part. When options or special features are supplied, refer to separate supplements and/or drawings furnished with this manual.

b. The first column in each parts table contains identifying numbers for assemblies, subassemblies, or parts that are pointed out in the accompanying parts location illustration. Esterline Angus part numbers for all replaceable items appear in the Part Number column, while a nomenclature for each part is found in the Description column. The number represented in the Qty. column refers to the quantity used in the assembly covered under the title of each particular list.

c. All components known to have an unavoidably high mortality rate under normal usage or any items that are expendable will have a check mark entered in the (✓) column of each table. This check indicates a recommendation that a stock supply or spare part be maintained for the item.

5.2 ORDERING INFORMATION

All parts and recording supplies are available through Esterline Angus Sales Offices. To insure prompt delivery and receipt of parts that are compatible with your specific instrument, always mention the recorder Model Number and Serial Number--as well as the part number and description of all items requested.

NOTE: For replacement parts of optional attachments or special modifications, refer to supplemental listings and/or drawings supplied in the appendix of this manual.

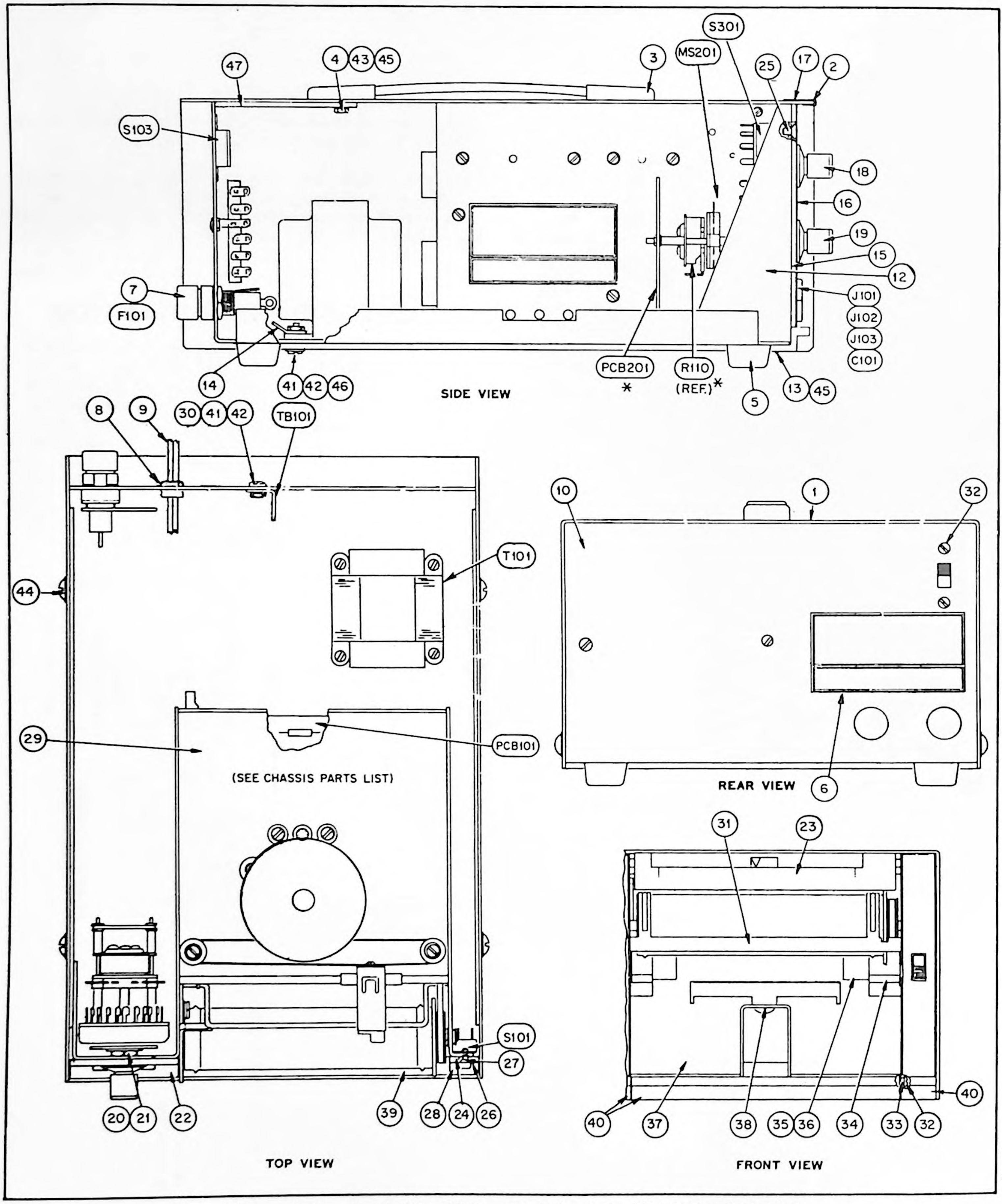


Figure 5-1. Bench-Top Miniservo Main Assembly Parts Location.

Table 5-1. Bench-Top Miniservo Main Assembly Parts List.

Fig. 5-1 Ref. No.	Part Number	Description	✓	Qty.
1	723D20	Cover, Bench-Top		1
2	723A49	Trim, Case		1
3	723A64	Handle, Case		1
4	ND40213-22	Screw, Case Handle		2
5	723A54	Foot		4
6	723A53	Decal, Information (Specify No's.)		1
F101	FAG2-.25*	Fuse, 1/4-Amp, Slow-Blow (115V Line)	✓	1 A/R
	FAG2-.125*	Fuse, 1/8-Amp, Slow-Blow (230V Line)	✓	1 A/R
7	14358	Holder, Fuse		1
	14355	Cap, Fuse-wiring insulator		1
8	BUS1	Grommet, Strain Relief		1
9	712A6	Cord, Power (3-Wire, 7A @ 125V)		1
10	723D21	Pan, Base (Chassis)		1
PCB101	723C43	PC Board Assy., Servo Amplifer	✓	1
11**	43140-4	Screw, PCB Mounting		8
12	723B28	Bracket, Mounting		1
13	43302-9	Screw, Trim Mounting		4
14	ND40036-002	Lug, Ground Terminal		2
15	723B30	Plate, Escutcheon Mounting (L.H.)		1
16	723B103	Escutcheon, L.H. (Multi-Span/Multi-Speed)		1
17	723A66	Decal, Logo		1
18	723A63	Knob, Switch		1
S301	723B13	Switch and Cable Assembly		1
19	723A121	Knob, Range Switch		1
MS201	723C42	Multi-Span Assy. (S102, PCB201, R110)		1
20	43118	Nut, Switch Mounting		4
21	SP1920	Washer, Lock		2
J101-J103	JAC12	Terminal, Front Input		3
C101	45304	Capacitor; 0.25µF, 400V	✓	1
22	723A133	Trim, Left-Front		1
23	See Data Sheet	Scaleplate		1
24	723B29	Plate, Escutcheon Mounting (R.H.)		1
25	NX10605	Screw, Plate Mounting		4
26	723A61	Escutcheon, Right-Hand		1
27	ND40210-5	Screw, Switch Mounting		2
28	723A134	Trim, Right-Front		1
29	723D4-8	Chassis Assembly (Table 5-2)		1
T101	723A139	Transformer Assy., Power (115/230V, 50/60 Hz)	✓	1
TB101	ND40074-19	Terminal Strip		1
30	NX90604	Screw, Terminal Strip Mounting		2
31	723B51	Hold-Down, Chart		1
32	ND40103-59	Screw, (#4-40 x 1/8")		4
33	723A77	Standoff		2
34	723A73	Chute, Loading		1
35	723A76	Wedge		3
36	STC4C31B	Screw, Self-Tapping, (#4 x 1/8")		3
37	723B50	Baffle		1
38	723A81	Wire, Retainer		1
39	723B36	Drawer Assembly		1
40	723B100-2	Trim, Brushed Aluminum		Set of 3
41	SP1906	Washer (No. 6)		6
42	X2106	Nut (No. 6)		6
43	43141	Nut (#4-40)		7

(Continued)

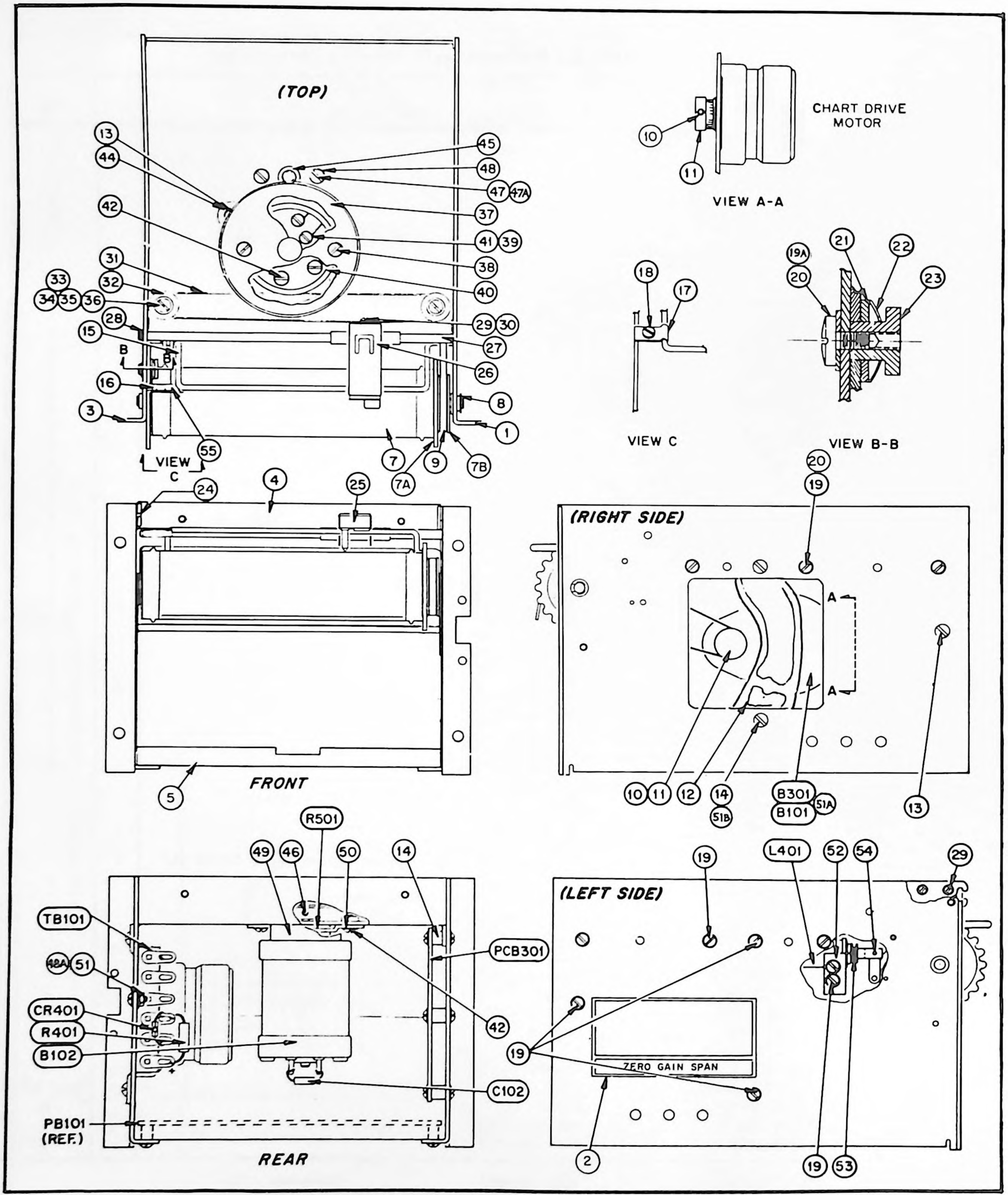


Figure 5-2. Chassis Assembly Parts Location.

Table 5-1. Bench-Top Miniservo Main Assembly Parts List (Cont'd.).

Fig. 5-1 Ref. No.	Part Number	Description	✓	Qty.
44	NX91104	Screw, Cover Mtg. (#10-32 x 1/4")		4
45	SP1904	Washer, Lock		14
46	NX90605	Screw, Transformer Mounting		4
47	723A124	Stop, Rear Panel		1
S103	57534	Switch (115/230V Selector)		1
S101	51166	Switch, Power (ON-OFF)		1
--	723A68-1	Service Kit (Accessories)		1

* Part of Kit No. 723A147. ** Not illustrated. A/R: As Required.

Table 5-2. Basic Chassis Assembly Replacement Parts List.

Fig. 5-2 Ref. No.	Part Number	Description	✓	Qty.
--	723D4-1	Chassis Assembly W/Single-Speed Chart Drive		1 A/R
--	723D4-8	Chassis Assembly W/Multi-Speed Chart Drive		1 A/R
--	723D4-3	Chassis Assembly W/Single-Speed & Elec. Pen Lift		1 A/R
1	723B113	.Sideplate Assembly (R.H.)		1
2	723A53	.Decal		1
3	723B7	.Sideplate Assembly (L.H.)		1
4	723B25	.Top Plate Assembly		1
5	723C10	.Plate, Paper Supply Compartment		1
7	723B24	.Drive Roll Assembly (Transport)		1
7A	45177	..Thumbwheel		1
7B	723A4	..Pulley, 40 Tooth		1
8	43006	."E" Ring, Retaining		1
9	70A199-3	.Belt, Timing	✓	1
10	723A2	.Pulley, Motor (60 Hz Operation)		1 A/R
	723A3**	.Pulley, Motor (50 Hz Operation)		1 A/R
11	HX20591	.Setscrew, Pulley Mounting		1
B101	723B18-*	.Motor, AC Timing (Single-Speed Drives)	✓	1 A/R
B301	723A116-2	.Motor, Stepper (Multi-Speed Drives)	✓	1 A/R
12	723C11	.Bracket, Motor Mounting		1
13	HX38017	.Screw, Mounting		A/R
14	HX38034	.Screw, (8-32 x 3/8")		1
PCB301	723B53-*▲	.PC Board Assembly, Stepper Drive	✓	1 A/R
15	723A38●	.Bail, Pen Lift		1 A/R
	723A37▲	.Bail, Pen Lift		1 A/R
16	723A32	.Arm, Pen Lift		1
17	70A137 θ	.Clamp, Pen Lift		1
18	ND40213-69 θ	.Screw, Clamp Mounting		1
19	HX38001	.Screw		A/R
19A	ND40213-19	.Screw (#4-40 x 1/4")		1
20	ND40221-4	.Washer, Lock		A/R
21	723A56	.Washer (Pen Lift)		1
22	723A58	.Washer, Spring (Pen Lift)		1
23	723A57	.Washer, Hat-Type (Pen Lift)		1
24	723B35	.Clip, Scale Mounting		2
25	723A26	.Pen Module	✓	1
26	723A42	.Holder, Pen Module		1
27	723A22	.Rod, Guide		1
28	ND40143-1	."E" Ring, Retaining		1
29	NX30202	.Screw, Mounting		5
30	NX1002	.Washer		2
31	01523	.Cable, Servo Drive	✓	A/R

(Continued)

Table 5-2. Basic Chassis Assembly Replacement Parts List (Cont'd.).

Fig. 5-2 Ref. No.	Part Number	Description	✓	Qty.
32	723A7	.Pulley, Servo Cable		2
33	723A6	.Spacer, Pulley Mounting		2
34	ND40213-31	.Screw, Pulley Mounting		2
35	723A16	.Bearing, Pulley Mounting		2
36	ND40213-27	.Screw, Pulley Mounting		2
37	723B79P	.Gear, 180-Tooth		1
38	43106-4	.Screw, Gear Mounting		3
39	HX30734-3	.Screw, 4-40 x 1/4"		2
40	723B101	.Pulley, Servo Motor		1
41	NX1004	.Washer		2
42	ND40213-38	.Screw		2
44	69140	.Bumper, Pulley Stop	✓	1
45	723A40	.Pinion Assembly		1
46	HX20591	.Setscrew		2
47	ND40213-34	.Screw		2
47A	723A136	.Washer, Shoulder (used with Ref. No. 47)		2
48	NX1106	.Washer		2
48A	SP1906	.Lockwasher		9
49	723A135	.Adapter, Motor		1
B102	723A118-1	.Servo Motor Assembly	✓	1
--	723B11	..Motor, Servo	✓	1
C102	40763-2	..Capacitor; 0.005μF, 1000V	✓	1
--	KPC21F	..Terminal, Wire	✓	2
--	0769	..Wire, Red		5"
--	0771	..Wire, Orange		5"
R501	723B88	.Potentiometer Assembly, Feedback; 5K	✓	1
--	723B19	..Potentiometer	✓	1
--	KPC21F	..Terminal, Wire	✓	3
--	0772	..Wire, Blue (22 Ga.)		7"
--	0791	..Wire, White/Orange (22 Ga.)		7"
--	0792	..Wire, White/Red (22 Ga.)		7"
R501A/B	*	.Potentiometer, Feedback W/Retrans. (Option)	✓	1 A/R
50	723A5	.Clamp		2
TB101	ND40074-19	.Terminal Board (Rack/Panel units only)		1
51	NX2006	.Nut, Terminal Board Mounting		A/R
--	0771	.Wire, Orange } Rack/Panel units only		11.5"
--	0769	.Wire, Red		11.5"
--	0772	.Wire, Blue		11.5"
--	KPC21F	.Terminal, Wire	✓	A/R
--	*	.Chart Paper	✓	1
51A	43302-2	.Screw, Pan-head (#8-32 x 3/8")		2
51B	1HN8-8	.Nut, Hex (#8-32)		1
		ELECTRIC PEN LIFT OPTION ●		
L401	723A39	.Solenoid, Pen Lift	✓	1 A/R
52	723A35	.Bracket, Solenoid		1 A/R
53	723A48	.Spring, Compression		1 A/R
54	ND40170-12	.Pin, Roll		1 A/R
CR401	43421	.Diode; 1N4004	✓	1 A/R
R401	RCC7-750	.Resistor; 75Ω, ±5%, 2W	✓	1 A/R
55	0704	.Tubing, Shrink		0.5"

* Refer to Data Sheet for Appropriate Part Number.

** Part of Kit No. 723A141.

▲ Supplied for Multi-Speed Drive only.

● Not used on Bench-Top units.

θ Not furnished when Electric Pen Lift option is supplied.

A/R: As Required.

Table 5-3. Replacement Parts List for Rack/Panel Chassis Assembly.▲

Fig. 5-3▲ Item No.	Part No.	Description	Quantity
—	723D8-■	Rack/Panel Chassis Assembly	1
1	723D4-1	.Chassis Assembly W/Single-Speed Chart Drive	1 A/R
	723D4-3	.Chassis Assembly W/Single-Speed & Elec. Pen Lift	1 A/R
	723D4-5	.Chassis Assembly W/Single-Speed & DC Chart Drive	1 A/R
2	723C27	.Z-Fold Slide & Box Assembly	1
3	723C26	..Slider, Drawer	1
4	723C25	..Plate, Drawer Base	1
5	723A82	..Slider, Drawer	1
6	STC4C31B	..Screw	1
7	723A87	..Washer, Drawer	1
8	723C24	..Box, Z-Fold	1
9	723A88	..Detent, Drawer	1
10	ND40103-59	..Screw, Binding Head Mach. (#4-40 x 1/8")	1
11	43074-1	..Screw, Flat Head Mach. (#4-40 x 3/16")	4
12¶	723B119	..Plate, Chart Accumulation	1
13	NX90806	.Screw (#8-32 x 3/8")	4
14	SP1908	.Washer (#8)	4
15	723B58	.Bracket, Terminal Block	1
16	NX90603	.Screw (#6-32 x 3/16")	4
17	SP1906	.Washer (#6)	4
18	17448	.Spacer	2
CP101	723C18	.Panel, Connection	1
* 20	723B59	.Panel, Rear	1 A/R
21	723B31	.Cover, Rear Terminal	1
22	43106-2	.Screw, Self-Tapping (#6)	4
23	HOL-1-11	.Holder, Fuse	1
F101	FAG2-.25	.Fuse, 1/4-Amp, Slow-Blow (115V Line)	1 A/R
	FAG2-.125	.Fuse, 1/8-Amp, Slow-Blow (230V Line).	1 A/R
24	NX90804	.Screw (#8-32 x 1/4")	A/R
25	70A34	.Terminal	A/R
—	723A85	.Chart Hold-Down & Chute Assembly	1
26	723B51	..Chart Hold Down	1
27	723A86	..Plate, Clamping	1
28	723B55	..Chute, Threading	1
29	723A84	.Wedge, Folding	1
30	ND40103-59	.Screw (#40-40 x 1/8")	2
31	HX38001	.Screw, Binding Head (#4-40 x 3/16")	2
32	ND40203-3	.Nut, Cad. Plated (#4-40)	2
32A	HX16332-2	.#6 Lockwasher	2
33	ND40160-1	.Button, Plug	2
34	43302-1	.Screw, Self-Tapping (#4)	2
35	723A83	.Plate, Support	1
36	ND40103-58	.Screw, Binding Head (#4-40 x 3/16")	6
36A	SP1904	.#4 Lockwasher	4
37	■	.Scaleplate	1
38	723B102	.Spring, Chart Stripper	1
39	723A137	.Rod, Support	1
T101	723B47-1	.Transformer, Power (120V, 50/60Hz)	1 A/R
	723B47-2	.Transformer, Power (240V, 50/60Hz)	1 A/R
PCB101	■	.PC Board Assembly, Servo Amplifier	1

A/R - As Required.
■ - See Data Sheet for Part Number.
* - Standard Items for Case-Mounted Rack/Panel Units; Optional for Chassis-Mounted Units.
▲ - Refer to Table 5-2 for Chassis Parts Not Illustrated in Fig. 5-3.
¶ - Not Used in all Versions.

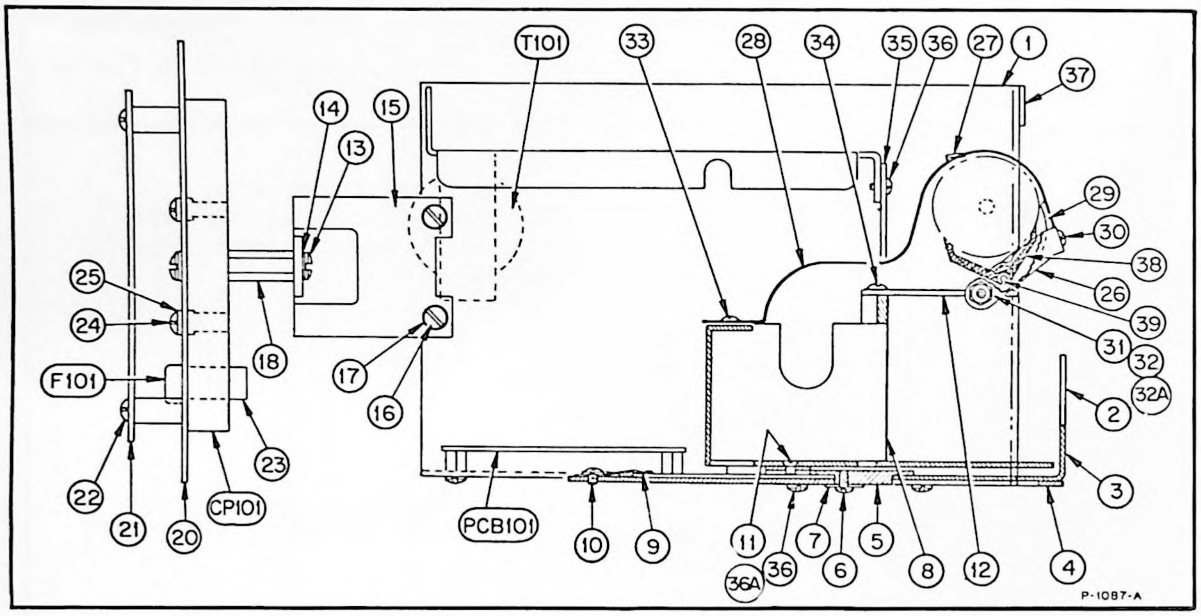


Figure 5-3. Rack/Panel Chassis Assembly Parts Location.

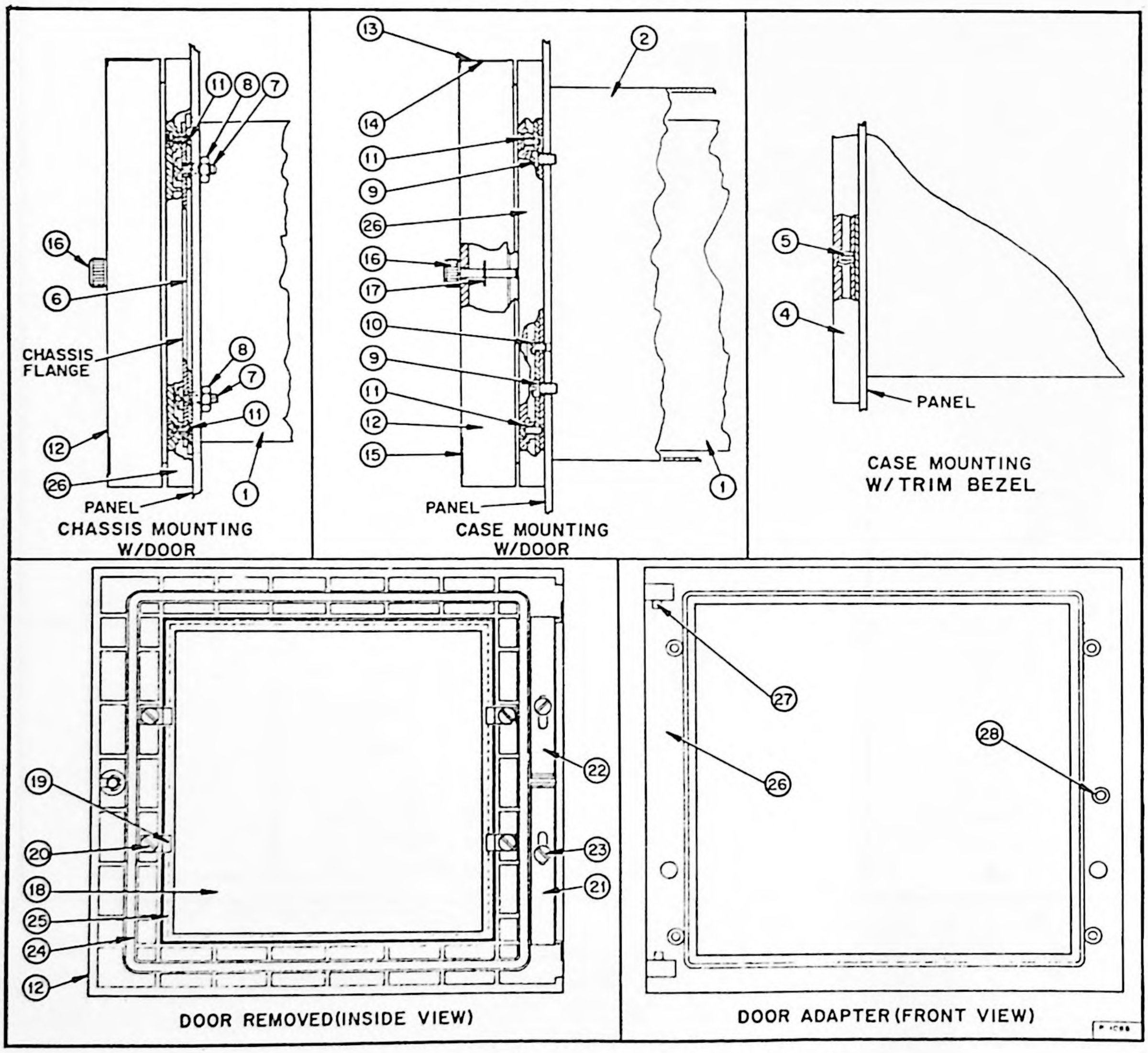


Figure 5-4. Rack/Panel Mount Parts Location.

Table 5-4. Replacement Parts List for Rack/Panel Mount Miniservo Recorders.

Fig. 5-4 Item No.	Part No.	Description	Quantity					
			723D12-■					
			-1	-2	-3	-4	-5	-6
—	723D12-1	Recorder, Panel Mount (Without Case)	1					–
—	723D12-2	Recorder, Panel Mount (With Case)		1				–
—	723D12-3	Recorder, Rack Mount (Without Case)			1			–
—	723D12-4	Recorder, Rack Mount (With Case)				1		–
—	723D12-5	Recorder, Panel Mount (With Case; No Door)					1	–
—	723D12-6	Recorder, Panel Mount (With Door; No Case)						1
1	723D8-■	.Chassis Assembly, Z-fold and Roll	1	1	1	1	1	1
2	723D7	.Case	–	1	–	1	1	–
*	■	.Adapter, Chassis Mounting, 19" Relay Rack	–	–	1	–	–	–
	■	.Adapter, Case Mounting, 19" Relay Rack	–	–	–	1	–	–
4	723D11	.Bezel, Trim	1	1	–	–	–	–
5	723A95	.Clip, Speed, Tubular Type	2	2	–	–	–	–
6	723A97	.Plate, Spacer	2	–	2	–	–	–
7	NX90808	.Screw (8-32 x 1/2")	4	–	4	–	–	–
8	NX2108	.Nut (8-32)	4	–	4	–	–	–
9	NX50604	.Screw (6-32 x 3/8")	–	4	–	4	4	–
10	ND40213-69	.Screw (4-40 x 1/8")	–	2	–	2	2	–
11	43140-4	.Screw (4-40 x 1/4")	–	–	4	4	–	–
12	723D10	.Door (Less Attaching Parts)	–	–	1	1	–	1
13	723A94	.Trim, Door	–	–	1	1	–	1
14	01301	.Loctite	–	–	A/R	A/R	–	1
15	723A96	.Escutcheon	1	1	1	1	–	1
16	723A92	.Screw, Panel	–	–	1	1	–	1
17	43007	.Ring, "E"	–	–	1	1	–	1
18	723A90	.Glass, door	–	–	1	1	–	1
19	70A137	.Clip, Glass	–	–	4	4	–	4
20	43302-1	.Screw, Self-Tapping (#4)	–	–	4	4	–	4
21	723B57-2	.Bracket, Hinge (Bottom)	–	–	1	1	–	1
22	723B57-1	.Bracket, Hinge (Top)	–	–	1	1	–	1
23	43302-2	.Screw, Self-Tapping (#4)	–	–	2	2	–	2
24	723A89	.Cord, Rubber	–	–	2 FT.	2 FT.	–	2 Ft.
25	723A91	.Tape, Foam	–	–	2 FT.	2 FT.	–	2 Ft.
26	723B56	.Door Adapter Assembly	–	–	1	1	–	–
—	723D9	..Adapter, Door (Less Attaching Parts)	–	–	1	1	–	–
27	57063-2	..Pin, Driv-Lok	–	–	2	2	–	–
28	723A93	..Insert, Threaded	–	–	1	1	–	–

A/R - As Required.
* - Item Not Illustrated; Dimensions and Color Dependent Upon Customer Requirements - See Data Sheet.
■ - See Data Sheet for applicable Part Number.

Table A-1. Replacement Parts For Option Items

Fig. A-1 Ref. No.	Part No.	Description	Quantity 723C51-☐ 1	2	3	4	5
	723C51-☐*	Power And/Or Multispeed Chart Drive Options					
1	723A158	Label, Switch, "Off-On"	1	-	1	--	-
2	723A159	Bracket, Switch Mounting	1	1	1	1	1
3	723A160	Label, Switch, "Off-Standby-On"	1	-	-	-	1
4	723A166	Assy., Switch	1	-	1	1	-
5	723A167	Label, Switch, "Chart Off-On"	-	-	-	1	-
6	723B123	Assy., Switch, "Off-Standby-On"	-	1	-	-	-
7	723B127	Assy., Switch, "Off-Standby-On" Multispeed	-	-	-	-	1
8	16765278-203	Screw, #2-56 X ¼ LG Pan HD Mach.	2	2	2	2	2
9	16765278-215	Screw, #4-40 X 3/8 LG Pan HD Mach	1	1	1	1	1
10	ND40082-004	P-Clamp, ¼ I.D.	1	1	1	1	1
11	ND40122-6	Nut, #4-40 X .093 THK X .250 A/Flats	1	1	1	1	1
12	NX1004	Flatwasher, #4 X .281 O.D. X .119 I.D. X .025 THK	1	1	1	1	1

*Refer to Instrument Data Sheet for Specific Part Supplied.

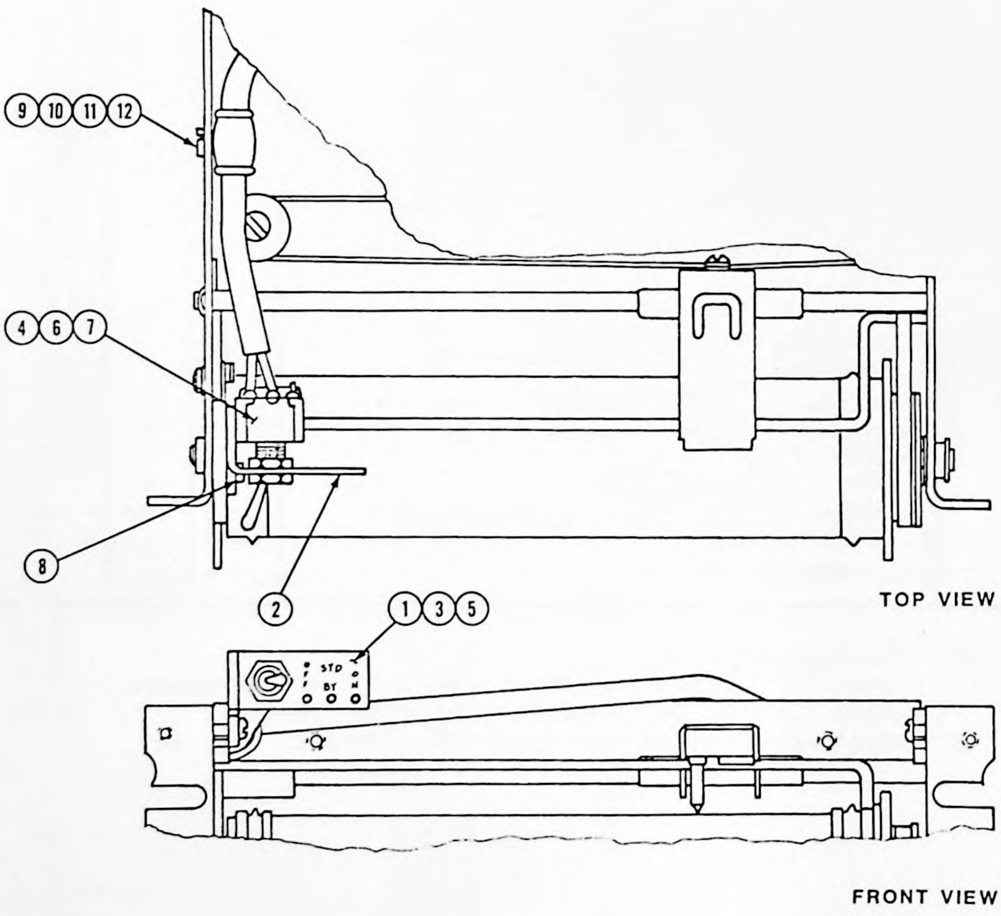
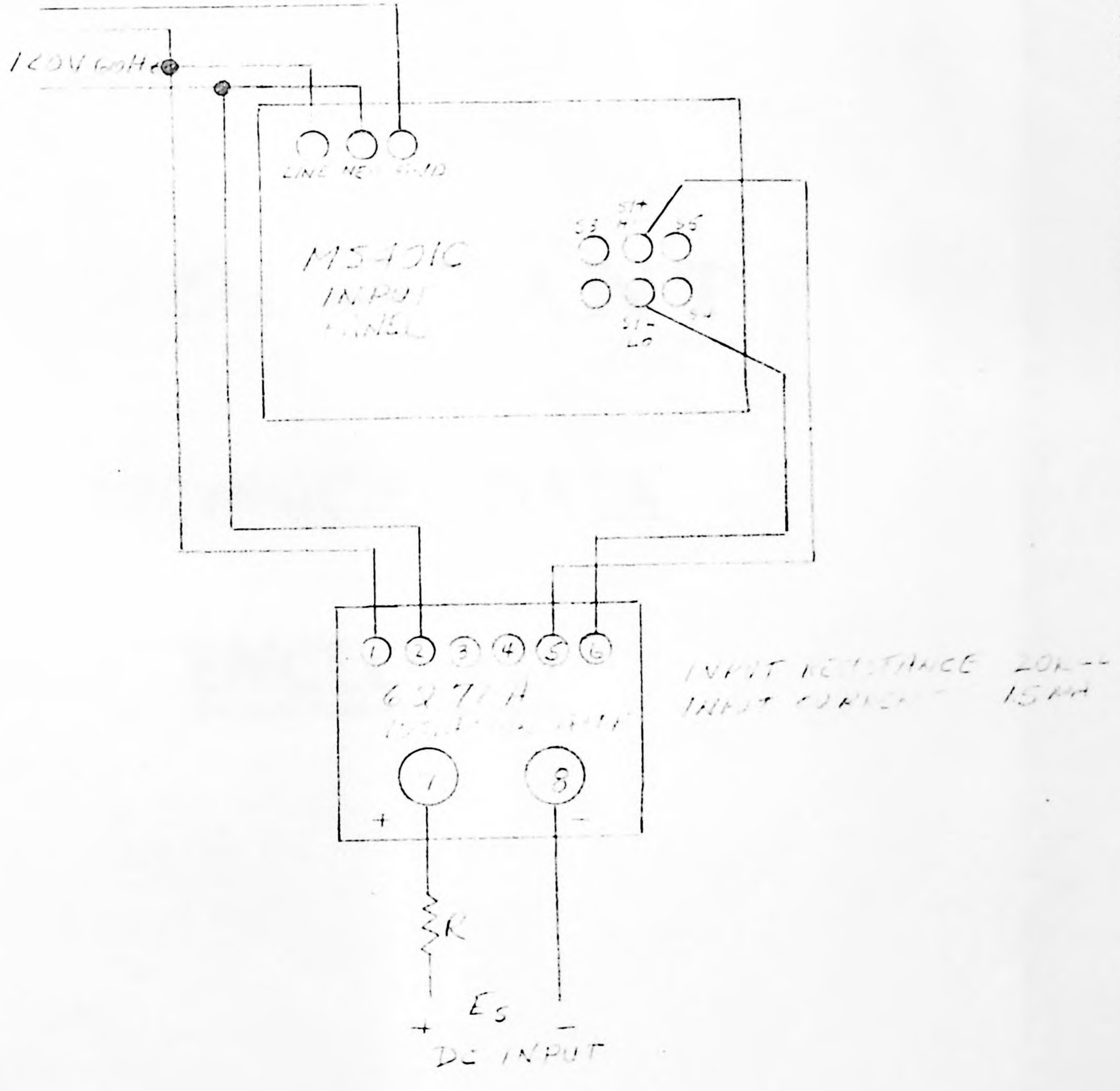


Figure A-1. Part of Front and Top Views of Chassis Assembly.

MS 401C WIRING DIAGRAM
ISOLATION - RECORDER



INPUT RESISTANCE 20K
INPUT CURRENT 15MA

DC INPUT	R
5000 V DC	3.31 MEGOHM
2500 V DC	1.65 MEGOHM

M 37026B #C
86010124-[illegible]
21-27

NO. M 23449A86-2

m GK 5-25-8

IMPORTANT

TECHNICAL DATA

ENCLOSED

ANGUS ELECTRONICS

Sales and Service Worldwide

Instrumentation Needs: Our local representatives are ready to help you with your instrumentation requirements. Angus Electronics has local representation, in most major cities throughout the United States, and throughout the world. Call Angus Electronics Customer Service Department to learn of the Angus representative nearest you.

Rental Program: Have a short-term need? In a hurry for a special instrument? Call us and learn about our convenient rental program. We can have most instruments out the door within hours after receiving your order. You always have an option to purchase any instrument you rent, and your previous rental payments are applied toward the purchase of the instrument. Call Angus Electronics and ask for the Rental Program Manager for complete details.

Supplies Ordering Service: Order the charts, pens, inks and other supplies you may need quickly and easily. Call Angus Electronics for details or a complete supplies catalog.

Service: For preventive maintenance, calibration and repair, our service department and local service locations will respond to your needs promptly and efficiently. Call Angus Electronics Service Manager for details.

Contact your local Angus representative for details on any of these services, or call Angus Electronics toll-free at

800-899-7611

Esterline ANGUS

Angus Electronics Co.
Instrumentation Group, Esterline Technologies
1201 Main Street
Indianapolis, IN 46224
Phone: 317/244-7611
Fax: 317/247-4749

DEC. 1992 2-26

~~941260~~
946580
12/04/92

REPORT ID DEDATA1

PRODUCT DATA SHEET
ANGUS ELECTRONICS COMPANY
BOX 24000, INDIANAPOLIS, IN. 46224 U.S.A.
TELEPHONE - A/C 317-244-7611

CUSTOMER: 082977

SOLD TO:

US NAVAL BASE
REGIONAL CONTRACTING OFFICER
BLDG 600
PHILADELPHIA, PA 19112-5082

SHIP TO:

US NAVAL ELECTRONIC SYS ENGR
ACTIVITY/OSCAR HANS/CODE 2255
RCP# N65980-92RC-21254
VILLA ROAD
ST INIGOES, MD 20684-0010

CUSTOMER ORDER: N00140-93C-AB62
EA ORDER: M44840 LINE: 07
TOTAL ORDER QTY: 3
SHOP ORDER: ____________

MODEL DESC. MS PANEL MOUNT CASE
MODEL NUMBER MOD:MS401C-(B)-50-(C)-110-(D)-61-(E)-
CON:LZ-15-LP-RA1-31

MS401C MS PANEL MOUNT CASE
MINISERVO SINGLE CHANNEL PANEL MOUNT CASE
ITEMS FURNISHED WITH ABOVE UNITS:
(3) M723A MANUALS
(3) 723A68 ACCESSORY KITS
S/N 92490030-32
ITEM 0003AA

50	50	1 MADC, SINGLE RANGE 20% ZERO ADJUST 401119
110	110	SINGLE SPEED 10 CM/HR 120 VAC 723B18-44
61	61	120 VAC 60 HZ 401068
LZ	LZ	LEFT HAND ZERO.
15	15	NEW SCALE DESIGN, SPECIFY MARKINGS. CUSTOM PRODUCTS.
LP	LP	LEGEND PLATE TWO TAG "G823126-4 & G823126-5" INSTALL ON FRONT OF LEFT SIDE OF CHART DRIVE. PER S23266-4 & -6.
RA1		ADAPTER TO FIT S601R CUTOUT PER S23379
31	31	CUSTOMER NAMESTRIP. SPECIAL LOGO STRIP "CABLE VOLTAGE" PER S23267-2

FURNISH WITH 2 SCALE (1) 0-5000 VDC 723A55-288A & S22674-31
(1) 0-2500 VDC 723A55-383A & S22674-31

SCALE INFORMATION: SCALE A ________ SCALE B ________ SCALE C ________

MANUAL SUPP MS33449A86-2 CHART 59007

CALIBRATE AS A SYSTEM WITH 6271A ISOLATION AMPLIFIERS WITH SAME SER #

CS PREP DATE 12/04/92 RECV IN PC ________ SCH SHIP DATE ________ 1-3

7/3

ASSEMBLER ________ CALIBRATOR JM 2-24-93 INSPECTOR

~~SERIAL NUMBER~~

92490030-32

DEC. 17 1992 2 26

940680
for
03

ANGUS ELECTRONICS CORP
P.O. BOX 24000 INDIANAPOLIS, IN 46224
(317) 244-7611

INSTRUMENT DATA SHEET - CUSTOMIZED SPECIFICATIONS

DATE 12-4-92 S.O.# M44840

Sold To U.S. NAVAL BASE PHILADELPHIA PA

Purchase Order No. N00140-93C-AB62 M.O.#

For Use By

(02) FURNISH 13 6271A ISOLATION AMPLIFIERS
INPUT 0-100MVDC OUTPUT 0-1.0 MADC
TAG "G823125-1" PER S23266-2
SER # 92490007-19

(03) FURNISH 13 8850S SHUNT BOXES PER S23268
TAG "G823180-1" PER S23266-3
SER # 92490007-19

(08) FURNISH 13 6271AX ISOLATION AMPLIFIERS FOR
LINE ITEMS 5-6&7 AS FOLLOWS

(5) INPUT 1.5MA/30VDC OUTPUT 0-1.0 MADC
TAG "G823124-5" PER S23266-7
SER # 92490020-24

(5) INPUT 1.5MA/30VDC OUTPUT 0-1.0 MADC
TAG "G823124-4" PER S23266-5
SER # 92490025-29

(3) INPUT 1.5MA/30VDC OUTPUT 0-1.0 MADC
TAG "G823124-4&5 PER S23266-8
SER # 92490030-32

DS______Inst. Card Entry________
Calib by______Final Inspection________
Date________

SERIAL NO. 92490007-32

DSCS